2023 DRAFT COASTAL MASTER PLAN

50-YEAR FWOA MODEL OUTPUT, REGIONAL SUMMARIES – RISK

ATTACHMENT C3

REPORT: VERSION 01

DATE: JANUARY 2023

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COASTAL PROTECTION AND RESTORATION AUTHORITY

This document was developed in support of the 2023 Coastal Master Plan being prepared by the Coastal Protection and Restoration Authority (CPRA). CPRA was established by the Louisiana Legislature in response to Hurricanes Katrina and Rita through Act 8 of the First Extraordinary Session of 2005. Act 8 of the First Extraordinary Session of 2005 expanded the membership, duties, and responsibilities of CPRA and charged the new authority to develop and implement a comprehensive coastal protection plan, consisting of a master plan (revised every six years) and annual plans. CPRA's mandate is to develop, implement, and enforce a comprehensive coastal protection and restoration master plan.

CITATION

Fischbach, J.R., Johnson, D.R., Wang, J., Hemmerling, S., Cobell, Z., Diaz, O. (2023). 2023 Draft Coastal Master Plan: Attachment C3: 50-Year FWOA Model Output, Regional Summaries. Version I. (p.275). Baton Rouge, Louisiana: Coastal Protection and Restoration Authority.

ACKNOWLEDGEMENTS

This document was developed as part of a broader Model Improvement Plan in support of the 2023 Coastal Master Plan under the guidance of the Modeling Decision Team (MDT):

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EXECUTIVE SUMMARY

This report describes the simulation modeling results projecting coastal flood risk and damage over a 50-year period in a future without action (FWOA). Results described in this analysis were simulated with the Coastal Louisiana Risk Assessment (CLARA) model to inform the development of Louisiana's 2023 Coastal Master Plan. The FWOA represents a projected future condition with changing environmental and population conditions.

Specifically, results are presented for two scenarios representing different rates of future sea level rise (SLR), changes to hurricane intensity, and other key environmental factors. Flood damage results also reflect one scenario of projected future population change in Louisiana's coastal parishes. These FWOA conditions serve as a baseline against which individual risk reduction projects and the 2023 Coastal Master Plan can be compared against to evaluate benefits. However, the scenarios shown represent only two of many possible futures for the Louisiana coast and should be interpreted as plausible projections rather than likely predictions for future flood risk outcomes.

The document presents and describes results for five different regions of Louisiana's coast: Pontchartrain/Breton, Barataria, Terrebonne, Central Coast, and Chenier Plain. This approach is consistent with the presentation of biophysical outcomes from the Integrated Compartment Model (ICM), which served as a key input for this analysis. The report first describes the overall geography and population characteristics for each region and then presents projected FWOA storm surge and wave heights, flood depths, exposure of single-family residences, and flood damage for each region.

The CLARA model was originally created by researchers at RAND Corporation to support development of Louisiana's 2012 Coastal Master Plan. It is designed to estimate flood depth exceedances, direct economic damage exceedances, and expected annual damage in dollars (EADD) and expected annual structural damage (EASD) in the Louisiana coastal zone. The model uses high-resolution hydrodynamic simulations of storm surge and waves as inputs. Monte Carlo simulation is used to estimate risk under a range of assumptions about future environmental and economic conditions and with different combinations of structural and nonstructural risk reduction projects on the landscape.

Looking coastwide, the FWOA flood risk analysis results show dramatic increases in flood depths, community and asset exposure to flooding, and flood damage over the 50-year projection if no additional action is taken. These increases are noted in both scenarios and across all regions of the coast, but the higher scenario, in particular, shows accelerating exposure and damage in later decades (Year 40-50) driven primarily by an accelerating rate of SLR. Present and future flood risk results described in this report demonstrate the need to take action in the master plan in order to reduce risk to people and assets across Louisiana's coastal communities.

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LIST OF ABBREVIATIONS

AEP .... ANNUAL EXCEEDANCE PROBABILITY
ADCIRC .... ADVANCED CIRCULATION
CLARA .... COASTAL LOUISIANA RISK ASSESSMENT
CPRA .... COASTAL PROTECTION AND RESTORATION AUTHORITY
EADD...EXPECTED ANNUAL DAMAGE IN DOLLARS
EASD .... EXPECTED ANNUAL STRUCTURAL DAMAGE
FWOA ....FUTURE WITHOUT ACTION
GIWW...GULF INTRACOASTAL WATERWAY
HSDRRS .... HURRICANE STORM DAMAGE AND RISK REDUCTION SYSTEM
ICM ....INTEGRATED COMPARTMENT MODEL
LOOP .... LOUISIANA OFFSHORE OIL PORT
NOV .... NEW ORLEANS TO VENICE
NSI .... NATIONAL STRUCTURE INVENTORY
OCS .... OUTER CONTINENTAL SHELFF
RSLR ....RELATIVE SEA LEVEL RISE
SLR ....SEA LEVEL RISE
SWAN ....SIMULATING WAVES NEARSHORE
USACE ....U.S. ARMY CORPS OF ENGINEERS
WSLP.. WEST SHORE OF LAKE PONTCHARTRAIN

1.0 INTRODUCTION

1.1 PURPOSE OF THIS REPORT

This report describes the simulation modeling results projecting coastal flood risk and damage over a 50-year period in a future without action (FWOA). Results described in this analysis were simulated with the Coastal Louisiana Risk Assessment model (CLARA) to inform the development of Louisiana's 2023 Coastal Master Plan.

The FWOA represents a projected future condition with changing environmental and population conditions. Specifically, results are presented for two scenarios representing different rates of future sea level rise (SLR), changes to hurricane intensity, and other key environmental factors. Flood damage results also reflect one scenario of projected future population change in Louisiana's coastal parishes. These FWOA conditions serve as a baseline against which individual risk reduction projects and the 2023 Coastal Master Plan can be compared against to evaluate benefits. However, the scenarios shown represent only two of many possible futures for the Louisiana coast and should be interpreted as plausible projections rather than likely predictions for future flood risk outcomes.

The document presents and describes results for five different regions of Louisiana's coast. This approach is consistent with the presentation of biophysical outcomes from the Integrated Compartment Model (ICM), which served as a key input for this analysis. The report first describes the overall geography and population characteristics for each region and then presents projected FWOA storm surge and wave heights, flood depths, exposure of single-family residences, and flood damage for each region.

This report should be of interest to the Coastal Protection and Restoration Authority (CPRA) and technical professionals and researchers in the field of flood risk assessment.

1.2 THE ADCIRC AND SWAN MODELS

The Advanced Circulation (ADCIRC) and Simulating Waves Nearshore (SWAN) model geometries used throughout Louisiana's 2023 Coastal Master Plan are derived from those used in both the 2012 and 2017 Coastal Master Plans, with incremental upgrades. Prior to Louisiana's 2023 Coastal Master Plan, an extensive model validation and calibration study was conducted by Cobell and Roberts (2021) to ensure that the parameters used within the model were most appropriate from those currently found within the modeling community and available literature. The ADCIRC+SWAN model version used in this work is v55.00 and represents the latest available enhancements to the model formulations at the time that the study was conducted.

1.3 THE CLARA MODEL

The CLARA model was originally created by researchers at RAND Corporation to support development of Louisiana's 2012 Coastal Master Plan. It is designed to estimate flood depth exceedances, direct economic damage exceedances, and expected annual damage in dollars (EADD) and expected annual structural damage (EASD) in the Louisiana coastal zone. The model uses high-resolution hydrodynamic simulations of storm surge and waves as inputs. Monte Carlo simulation is used to estimate risk under a range of assumptions about future environmental and economic conditions and with different combinations of structural and nonstructural risk reduction projects on the landscape.

The CLARA model is well described in prior peer-reviewed and published literature, so this report does not include detailed descriptions of the basic methodological approach and assumptions. For interested readers, an introduction to the model can be found in Johnson et al. (2021a), Fischbach et al. (2012), and Johnson et al. (2013). Model improvements for the 2017 Coastal Master Plan are described in Fischbach et al. (2017), and published examples of CLARA model results can be found in Fischbach et al. (2019), Meyer & Johnson (2019), and Fischbach et al. (2017). Model improvements for Louisiana's 2023 Coastal Master Plan are described in Fischbach et al. (2021). Finally, an overall summary of the CLARA methodology as applied in the 2023 analysis can be found in Johnson et al. (2021b).

CLARA estimates flood depths at different annual exceedance probabilities (AEPs; e.g., 1% annual chance or 1 in 100-year flood depth) for grid cells across the Louisiana coast. In addition to depth results, two primary metrics are presented for flood exposure and damage estimates from the CLARA model in this report: 1) the exposure of single-family residences to flooding at one of three severity thresholds; and 2) projected flood damage across all asset types summarized as EADD or EASD, an alternate metric designed to be less sensitive to high-value assets in comparatively wealthier areas. The exposure thresholds are based on flood depths with a 2% (1 in 50-year) chance of occurring, and the comparisons are based on a structure inventory estimated for Year 0 that does not vary over time.[1] The thresholds include:

- **Structures Where Flooded**: CLARA model projections show non-zero flood depths for the grid cell in which the structure is located.
- **Moderate Exposure:** CLARA model projections show flood depths above the first-floor elevation of the structure — a threshold beyond which moderate to major damage is expected to occur.
- **Severe Exposure**: CLARA model projections show flood depths that are 2 or more feet above the first-floor elevation of the structure — major damage to structure and contents would be expected.

[1] CLARA damage estimates take into account population change over time (see Hauer et al., 2022), but these changes are not directly incorporated into the inventory of structures. As a result, structure exposure is based on the inventory at Year 0, and the number of structures remains fixed over the period of analysis. For more information, see Fischbach et al. (2021).

Results are mapped for each community and summarized across the region as a whole. Mapped exposure results highlight the percent of homes at or above the moderate exposure threshold. Methods used for estimating EADD and EASD with CLARA are described in separate reports (Fischbach et al., 2021; Johnson et al., 2021a).

1.4 ORGANIZATION OF THIS REPORT

This report is organized around five regions identified for coastal Louisiana (from east to west): Pontchartrain/Breton, Barataria, Terrebonne, Central Coast, and Chenier Plain. Each chapter first provides a descriptive overview of the region, including its geography, key structural protection features, and population characteristics. Next, an overview of key risk results is included as a summary for each region.

The sections following the risk summary in each regional chapter present and discuss more detailed FWOA results. First, storm surge and wave simulations in ADCIRC and SWAN are presented for a selected set of individual storm runs to highlight key points. The next section describes CLARA estimates of flood depths and damage at different AEPs and summarized as EADD or EASD. Each chapter concludes with a discussion of highlights and key themes from the new analysis.

2.0 PONTCHARTRAIN/BRETON

2.1 DESCRIPTION

GEOGRAPHY

The Pontchartrain/Breton region is bounded on the east by two sounds of the Gulf of Mexico, Breton Sound and Chandeleur Sound and on the west by the Mississippi River. The lower extent of the region also contains the active Mississippi River Delta. The ecology of the region is dominated by coastal intertidal areas, including intermediate, brackish, and saline marshes, and subtidal and submerged bottoms, including subtidal soft bottoms and submerged aquatic vegetation, with human development concentrated along the limited high ground (Figure 1). Much of this development centers on the Mississippi River and the north shore of Lake Pontchartrain and includes a combination of urban, suburban, and rural/agricultural development. This includes the New Orleans Metropolitan Area, with a highly concentrated population of 1.2 million persons. North of Lake Pontchartrain, most of the development occurs along a series of Pleistocene terraces, the oldest and highest of each are located in the Florida Parishes stretching from East Baton Rouge Parish to St. Tammany Parish. This includes the Northshore suburban communities of Mandeville, Covington, Abita Springs, Madisonville, Pearl River, Lacombe, and Slidell.

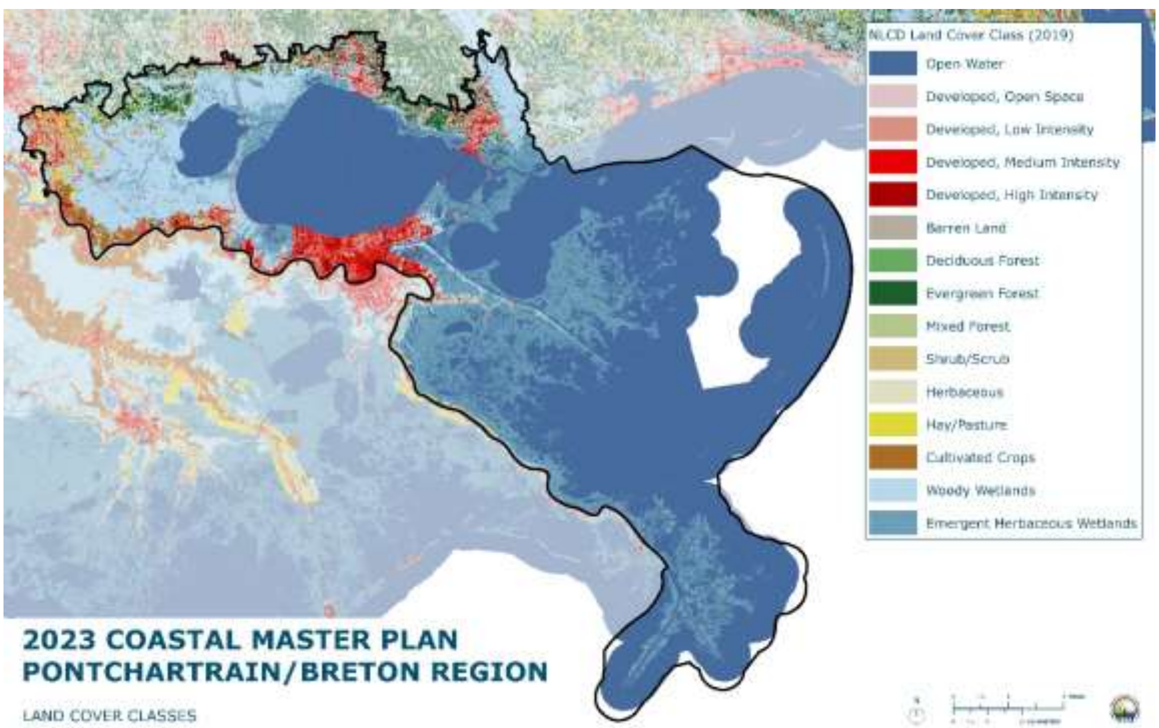

Figure 1. Land cover types in the Pontchartrain/Breton region

STRUCTURAL PROTECTION

While the elevation of the Pleistocene terraces provides a degree of protection from coastal storm and riverine flood events for many of the communities located on the Northshore, the communities located along the Mississippi River are reliant upon additional structural protection (Figure 2). A series of federal river levees and floodwalls reinforce the natural levees of the Mississippi River, providing protection from riverine flooding for communities in the Pontchartrain/Breton region from the River Parishes to the Mississippi River Delta. In addition, the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS), a series of levees and floodwalls engineered to provide a 100-year level of risk reduction against tropical events and related rainfall and storm surges, was constructed following Hurricane Katrina to protect the densely populated locations within Orleans, Jefferson, St. Bernard, St. Charles, and Plaquemines parishes.

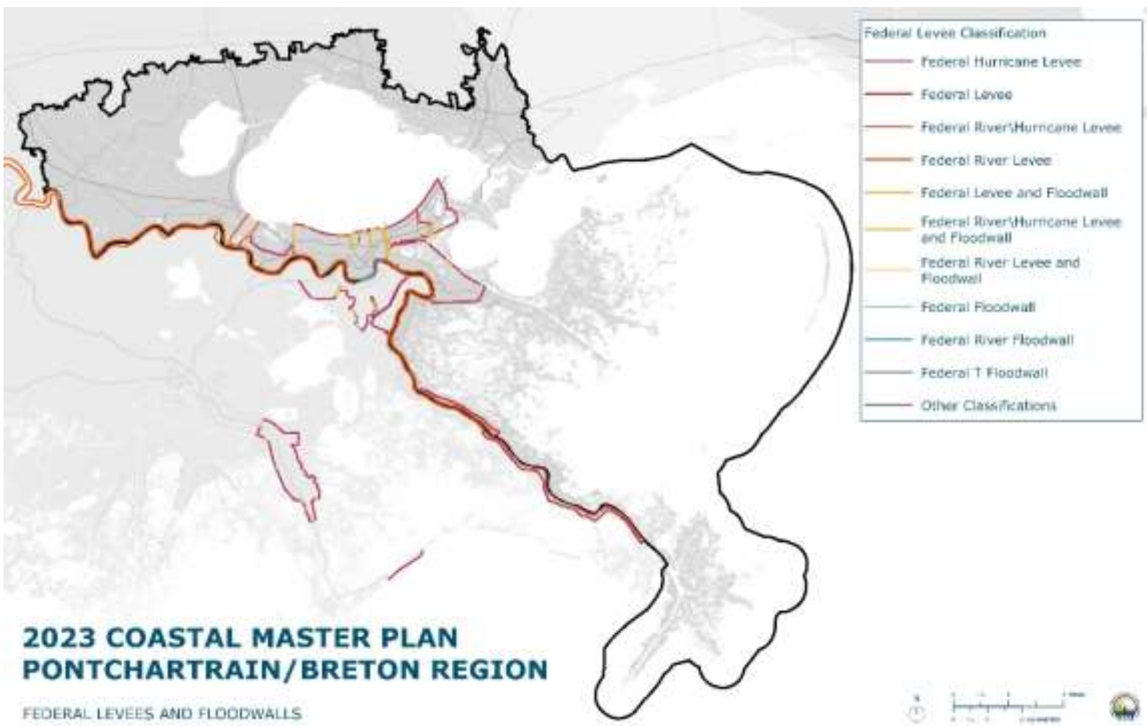

Figure 2. Structural protection in the Pontchartrain/Breton region

POPULATION[2]

The Pontchartrain/Breton region is composed of three coastal basins: Pontchartrain, Breton Sound, and Mississippi River Delta. The Mississippi River flows through all three basins, yet each has its own unique physiography and related human and cultural geography.

PONTCHARTRAIN BASIN

The Pontchartrain Basin, located in the northern portion of the Pontchartrain/Breton region, includes lakes Maurepas, Pontchartrain, and Borgne, which cover the majority of the area of the basin. Lake Maurepas is surrounded by the Maurepas and Manchac swamps and separated from Lake Pontchartrain by a land bridge of cypress swamp and fresh/intermediate marsh. The Orleans Land Bridge, which includes Lake Catherine, is an area of brackish marsh that separates Lake Pontchartrain from Lake Borgne. Beyond Lake Borgne is Biloxi Marsh, an area of coastal brackish and saline marsh and submerged bottoms extending to Chandeleur Sound.

Beyond the large areas of open water, swamp, and marsh, the Pontchartrain Basin is also the most densely populated region in Louisiana, containing portions of nine Louisiana parishes: Ascension, Jefferson, Livingston, Orleans, St. Bernard, St. Charles, St. James, St. John the Baptist, and St. Tammany. This includes the entirety of the city of New Orleans as well as Metairie and Kenner, two urbanized areas located in Jefferson Parish on the east bank of the Mississippi River. Together with Chalmette, a census designated place located to the east of New Orleans in neighboring St. Bernard Parish, these communities make up the New Orleans–Metairie–Kenner metropolitan statistical area (Figure 3).

[2] Community populations were interpolated using dasymetric mapping and combining the 2019 National Land Cover Database and 2020 Decennial Census block data, apart from poverty values, which were estimated from the 2016-2020 American Community Survey block group data. Due to the different census data source utilized for the poverty interpolation, the percentage values shown in this section for poverty will not be consistent with the total population values shown.

Figure 3. Population density of communities comprising the New Orleans Metropolitan region

The urbanized core of the New Orleans Metropolitan Area within the Pontchartrain/Breton region consists of the city of New Orleans and the Eastbank communities of Metairie and Kenner in neighboring Jefferson Parish, with other suburban cores stretching eastward along Lake Pontchartrain and into St. Bernard Parish along the Mississippi River. These areas, particularly the Eastbank of Jefferson Parish and St. Bernard Parish, saw populations boom between 1950 and 1980 with national trends towards suburbanization. The population of these locations largely stabilized after 1980, although Hurricane Katrina would result in a sharp downturn in the population of the regions (Zaninetti & Colten, 2012).

Given the urban character of the area, there is a large proportion of racial and ethnic minorities residing in the region. New Orleans, New Orleans East, and Poydras/Violet have a higher proportion of Black residents than the Louisiana average of 33% (Table 1). Similarly, the communities of Chalmette/Arabi/Meraux, Irish Bayou/Lake Catherine, the Eastbank communities of Jefferson Parish, and New Orleans East are home to high concentrations of Asian residents (relative to the statewide average of 1.9%). The region is also home to a significant number of Hispanic residents, with only New Orleans East not exceeding the statewide average of 5.6%

Finally, according to the U.S. Census Bureau, roughly 19.6% of Louisiana's residents reside below the poverty line. This number is exceeded in all of the identified communities in the New Orleans Metropolitan Area in the Pontchartrain/Breton region, with the exception of the Eastbank communities in Jefferson Parish and Irish Bayou/Lake Catherine.

Table 1. Demographics of communities comprising the New Orleans Metropolitan region

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	NATIVE AMERICAN	ASIAN	HISPANIC	BELOW POVERTY LEVEL
CHALMETTE/ ARABI/MERAUX	33,349	19,354	7,512	230	951	4,841	9,018
		58.0%	**22.5%**	**0.7%**	**2.9%**	**14.5%**	**22.8%**
IRISH BAYOU/ LAKE CATHERINE	841	663	50	1	54	53	96
		78.8%	**5.9%**	**0.1%**	**6.4%**	**6.3%**	**9.6%**
JEFFERSON PARISH (EASTBANK)	256,010	155,263	38,438	1,282	9,984	52,430	36,282
		60.6%	**15.0%**	**0.5%**	**3.9%**	**20.5%**	**12.8%**
NEW ORLEANS	260,734	114,837	112,173	998	4,992	22,982	55,948
		44.0%	**43.0%**	**0.4%**	**1.9%**	**8.8%**	**21.0%**
NEW ORLEANS EAST	74,539	1,605	63,469	208	4,479	4,141	27,408
		2.2%	**85.1%**	**0.3%**	**6.0%**	**5.6%**	**29.7%**
POYDRAS/ VIOLET	10,592	5,166	4,097	91	55	1,194	3,669
		48.8%	**38.7%**	**0.9%**	**0.5%**	**11.3%**	**23.2%**

Other developed areas located in the northern portion of the Pontchartrain/Breton region include Lake Pontchartrain's Northshore communities and the River Parishes, those parishes located along the Mississippi River between New Orleans and the southern suburbs of Baton Rouge. These locations have experienced tremendous population growth since 1980, when suburban development shifted to the north shore of Lake Pontchartrain, with a focus on St. Tammany Parish and upriver St. Charles and St. John the Baptist parishes to a lesser extent (Zaninetti & Colten, 2012). Following Hurricane Katrina, there was a sharp decline of residents residing in the New Orleans Metropolitan Area and a concurrent growth in population in the Northshore and the River Parishes, particularly along the interstate corridors that connect the urban centers of New Orleans and Baton Rouge (Hemmerling, 2017).

NORTHSHORE LAKE PONTCHARTRAIN

The portion of the Northshore area located within Louisiana's coastal zone (roughly equivalent to the area located south of Interstate 12) can be divided into the upland Pleistocene terrace, an elevated geological landscape made up primarily of silts, sands, and gravel deposits, and the lowland locations bounding Lake Pontchartrain, consisting in large part of brackish marsh along the Lake Pontchartrain shoreline. While much of the Northshore development has occurred beyond the wetland fringe of Lake Pontchartrain, population growth in the Northshore communities of Mandeville and Eden Isles have resulted in high population densities directly along the lakefront (Figure 4).

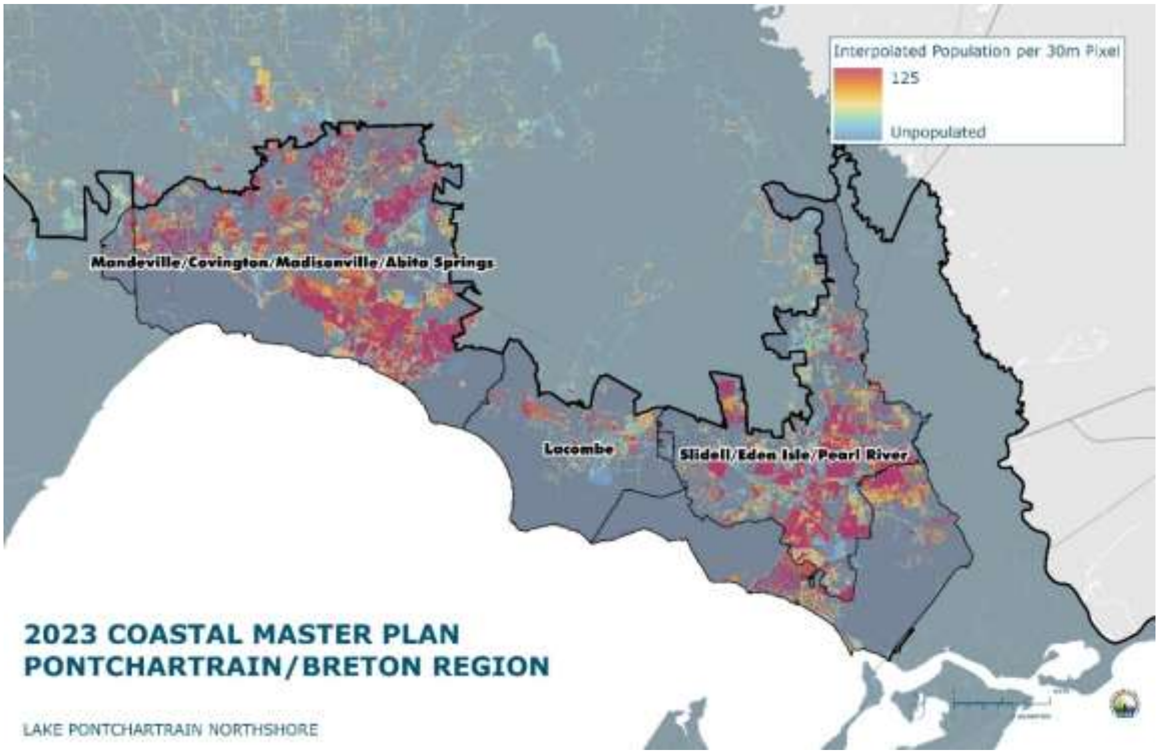

Figure 4. Population density of communities located on the north shore of Lake Pontchartrain

The demographic profile of the Northshore reveals a white population slightly higher than the overall state average of 62.4%, with only the Slidell/Eden Isle/Pearl River community having a slightly lower percentage than the state average (Table 2). All of the Northshore communities do have relatively large Hispanic populations, while Slidell/Eden Isle/Pearl River has an Asian population higher than the state average. Further, none of the communities examined had poverty levels exceeding the state average.

Table 2. Demographics of communities located on the north shore of Lake Pontchartrain

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	NATIVE AMERICAN	ASIAN	HISPANIC	BELOW POVERTY LEVEL
MANDEVILLE/ COVINGTON/ MADISONVILLE/ ABITA SPRINGS	113,856	92,302	7,246	369	1,671	9,495	9,447
		81.1%	**6.4%**	**0.3%**	**1.5%**	**8.3%**	**8.7%**
LACOMBE	9,313	6,003	1,871	73	60	776	1,612
		64.5%	**20.1%**	**0.8%**	**0.6%**	**8.3%**	**17.4%**
SLIDELL/ EDEN ISLE/ PEARL RIVER	107,795	66,958	26,356	600	2,318	8,089	14,820
		62.1%	**24.5%**	**0.6%**	**2.2%**	**7.5%**	**11.3%**

RIVER PARISHES AND LAKE MAUREPAS

The River Parishes are home to both agricultural production and industry. Sugarcane is the primary industry in the River Parishes, which have traditionally included St. Charles, St. James, and St. John the Baptist. Other important crops include soybeans, corn, hay, oats, and vegetables while other agricultural land in the region is used for beef cattle. Petrochemical plants located along this stretch of the Mississippi River account for approximately 25% of the petrochemical production in the United States. The majority of the population in this area is concentrated on the natural levees of the Mississippi River behind the protection of the federal river levees (Figure 5). The largest population concentrations are found in the suburban development west of the New Orleans Metropolitan Area (including Destrehan and Laplace) and the southern suburbs of Baton Rouge (Gonzales and Prairieville). Beyond the levee of the Mississippi River, settlement in this area largely occurs atop the elevated Pleistocene terrace located to the north of Lake Maurepas and the Maurepas Swamp stretching eastward to the Northshore communities.

Figure 5. Population density of communities located in the River Parishes and around Lake Maurepas

A large proportion of Black residents reside in the River Parishes, with many smaller communities far exceeding the statewide average of 33% (Table 3). Many of these communities have historically been agricultural and many of the Black residents residing there today are descendants of enslaved African Americans (Brewington, 2021). Today, the economy of the River Parishes relies upon not only agriculture but tourism (in the form of plantation tours) as well as petrochemical development along the Mississippi River.

The demographic profile of the communities located atop the Pleistocene terrace, including French Settlement, Killian, and Ponchatoula, is more closely aligned with the Northshore communities than many of the River Parish communities, with white populations higher than the overall state average of 62.4%. All of these communities also have poverty levels lower than the statewide average of 19.6%.

Table 3. Demographics of communities located in the River Parishes and around Lake Maurepas

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	NATIVE AMERICAN	ASIAN	HISPANIC	BELOW POVERTY LEVEL
BURNSIDE	4,385	2,466	1,638	9	43	0	170
		56.2%	**37.4%**	**0.2%**	**1.0%**	**0.0%**	**1.7%**
CONVENT/ ROMEVILLE	591	239	332	2	2	0	19
		40.4%	**56.2%**	**0.3%**	**0.3%**	**0.0%**	**30.2%**
DESTRAHAN/ NEW SARPY/ NORCO	15,728	11,197	2,689	50	187	10	1,288
		71.2%	**17.1%**	**0.3%**	**1.2%**	**0.1%**	**8.9%**
GARYVILLE	2,139	1,035	996	3	0	0	47
		48.4%	**46.6%**	**0.1%**	**0.0%**	**0.0%**	**24.3%**
GONZALES/ PRAIRIEVILLE	102,787	70,448	19,558	446	1,452	30	9,007
		68.5%	**19.0%**	**0.4%**	**1.4%**	**0.0%**	**7.6%**
GRAMERCY/ LUTCHER	10,828	6,733	3,729	20	23	4	161
		62.2%	**34.4%**	**0.2%**	**0.2%**	**0.0%**	**10.3%**
KILLIAN	1,177	954	141	0	4	0	46
		81.1%	**12.0%**	**0.0%**	**0.3%**	**0.0%**	**18.2%**
LAPLACE/ RESERVE	37,510	12,560	20,916	161	316	10	3,214
		33.5%	**55.8%**	**0.4%**	**0.8%**	**0.0%**	**17.0%**
MANCHAC	9	6	0	0	2	0	0
		66.7%	**0.0%**	**0.0%**	**22.2%**	**0.0%**	**12.5%**
MONTZ	2,061	1,555	311	17	9	0	116
		75.4%	**15.1%**	**0.8%**	**0.4%**	**0.0%**	**9.8%**
PONCHATOULA/ SPRINGFIELD	11,195	7,777	2,513	52	70	3	519
		69.5%	**22.4%**	**0.5%**	**0.6%**	**0.0%**	**14.2%**
PORT VINCENT/ FRENCH SETTLEMENT	2,820	2,544	30	9	23	0	94
		90.2%	**1.1%**	**0.3%**	**0.8%**	**0.0%**	**10.9%**
ST. ROSE	7,556	3,241	3,063	23	160	3	990
		42.9%	**40.5%**	**0.3%**	**2.1%**	**0.0%**	**11.0%**
UNION	744	154	571	0	0	0	3
		20.7%	**76.7%**	**0.0%**	**0.0%**	**0.0%**	**4.0%**

BRETON SOUND

The Breton Sound Basin is bounded on the west by the Mississippi River, on the north by Bayou La Loutre, on the east by the south bank of the Mississippi River Gulf Outlet, and on the south by Baptiste

Collette Bayou and Breton Island. Beyond the narrow thread of elevated land atop the Mississippi River levee, approximately 27% of the area contained in the basin is wetlands, with the remainder being open water or submerged bottoms.

The Breton Sound Basin includes the portion of Plaquemines Parish located on the east bank of the Mississippi River and St. Bernard Parish, two Louisiana parishes, downriver from New Orleans. As seen in other areas of the Pontchartrain/Breton region, much of the development in Plaquemines Parish has occurred atop the natural levees of the Mississippi River, stretching from Braithwaite down to Pointe a la Hache (Figure 6). Beyond the Mississippi River are found a number of small unincorporated fishing communities, including Delacroix and Yscloskey both located in St. Bernard Parish. Delacroix is located along Bayou Terre aux Bouefs, surrounded on all sides by bayous and wetlands. Yscloskey is an Isleño fishing community located near the southern shore of Lake Borgne on the northeastern bank of Bayou la Loutre and along both sides of Bayou Yscloskey.

Figure 6. Population density of Breton Sound communities

Both communities are predominantly white with a lower proportion of residents existing below the poverty line than the overall average for the state of Louisiana. Among the communities located on the east bank of the Mississippi River in Plaquemines Parish, we see a high proportion of Black residents relative to statewide averages. Nearly 84% of the residents residing in the communities stretching between the towns of Phoenix and Bohemia are Black, one of the highest percentages found in the

Pontchartrain/Breton region, second only to New Orleans East (Table 4). Nearly three-quarters of the residents of this community have income levels below the poverty line.

Table 4. Demographics of Breton Sound communities

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	NATIVE AMERICAN	ASIAN	HISPANIC	BELOW POVERTY LEVEL
BRAITHWAITE	591	320	205	0	3	0	66
		54.1%	**34.7%**	**0.0%**	**0.5%**	**0.0%**	**16.6%**
DELACROIX	58	49	1	0	0	0	14
		84.5%	**1.7%**	**0.0%**	**0.0%**	**0.0%**	**13.9%**
PHOENIX TO BOHEMIA	1,301	157	1,093	0	4	0	28
		12.1%	**84.0%**	**0.0%**	**0.3%**	**0.0%**	**72.2%**
YSCLOSKEY	71	49	5	0	1	0	14
		69.0%	**7.0%**	**0.0%**	**1.4%**	**0.0%**	**11.4%**

2.2 SUMMARY OF RISK

The following sections summarize the simulation modeling results projecting coastal flood risk and damage for the Pontchartrain/Breton region over a 50-year period in a FWOA. This includes projected storm surge and wave heights, flood depths, exposure of single-family residences, and flood damage. Fastlands are legally defined as lands surrounded by publicly owned or maintained levees or natural formations that prevent activities within the surrounding area from having a direct and significant impact on coastal waters. In general, model results suggest that the less populated communities located beyond these fastlands are expected to experience high projected flood depths and associated damages under current conditions, a trend that continues throughout the 50-year simulation period. Despite anticipated future landscape changes, ADCIRC simulations predict that SLR will be the most influential factor in increasing storm surge and flood depths. Prior to conducting the FWOA simulations for the Pontchartrain/Breton region, the ADCIRC model was updated to include the West Shore of Lake Pontchartrain (WSLP) levee system due to be constructed by the U.S. Army Corps of Engineers (USACE). Construction for the first reach of the WSLP levee system is set to begin in 2023, with expected completion in 2024 (USACE New Orleans District, 2022). Contracts for other WSLP levee reaches are currently being advertised, and the current construction schedule indicates that all levee reaches will be built to full heights by 2026 (Drouant, 2022).

STORM SURGE AND WAVES

ICM results show increased land elevations through many of the marshy areas of the Pontchartrain/Breton region over the first portion of the 50-year simulation period, which correspond to more surface roughness and bottom friction for storms traveling over these areas. These increased friction and topographic values are expected to decrease the ability of storm surge to move inland.

However, by Year 50, the models indicate less of an effect. Despite these changes in topography and frictional characteristics, ADCIRC simulations predict that SLR is the most influential factor in increasing water levels, storm surge, and waves. Under the lower and higher scenarios, increasing sea level will lead to greater peak water surface elevations and peak wave heights in the region.

Two populated locations within the Pontchartrain/Breton region are expected to be particularly vulnerable to the impacts of increased water depths, storm surge, and waves. The area near Braithwaite in the Breton Sound Basin shows the potential for surge amplification impacts. In this location, the geometry of Breton Sound may act as a funnel where the HSDRRS levees on the south side of St. Bernard Parish and the Mississippi River levees could focus surge across Breton Sound, from the fishing villages of Delacroix and Yscloskey in St. Bernard Parish toward Braithwaite on the east bank of the Mississippi River in Plaquemines Parish.

Additionally, model results show that the area between the west shore of Lake Maurepas and the River Parishes is not expected to flood under current conditions but will become increasingly at risk of inundation from the modeled storms in a FWOA. Even though this area is expected to exhibit relatively little change in frictional parameters and also sees an increase in topographic elevation, SLR will increase both water levels and wetted area across the area. Model results show that the area wetted under future storms may extend from the western edge of Lake Maurepas westward toward Gonzales/Prairieville.

FLOOD DEPTH AND DAMAGE

CLARA simulations for the Pontchartrain/Breton region show increases in the both the extent and depth of flooding over the 50-year period of analysis across the region. Building upon the results of the storm surge and wave analysis, this increase appears driven primarily by the rates of SLR utilized in each FWOA scenario. In the lower scenario, increases in flood depths tend to increase linearly over time. In the higher scenario, alternately, flood depth trends accelerate over time, particularly in the period between years 40 and 50. Basin wide damage estimates are expected to follow this same general trend, with an accelerating rate of increase in later decades in the higher scenario. In general, the less populated eastern and more coastward parts of the Pontchartrain/Breton region, including the marshy areas of the Breton Sound Basin in Plaquemines and St. Bernard parishes and fishing villages such as Delacroix and Yscloskey, are expected to experience high projected flood depths under current conditions, a trend that continues through the 50-year simulation period. However, these coastward areas are projected to decline in population in the coming decades in this analysis, and corresponding reductions are observed in projected damages in the simulation results.

This reduction in exposure and damage in the sparsely populated portions of the region is more than offset across the region by more densely populated areas facing significantly greater flood exposure. The northern and western portions of the Pontchartrain/Breton region, including the densely populated elevated land along the Mississippi River and atop the Pleistocene terrace stretching from St. Tammany Parish to East Baton Rouge Parish are expected to experience limited flood extents and depths under current conditions but show notable increases through the 50-year simulation period.

Given the population density of Lake Pontchartrain's Northshore communities in St. Tammany Parish, the increase in flood extents and depth in this area will result in significant increases in flood exposure and damage (Figure 7). For Northshore communities, this increase in exposure and damage is driven primarily by increasing flood depths over the 50-year simulation period. Slidell/Eden Isle/Pearl River appear to be of particular concern in later decades, with annual damage estimates exceeding $2 billion in the lower scenario and $3 billion in the higher scenario for this community alone. For River Parish communities to the west of Lake Maurepas, such as Gonzales/Prairieville, the change in flood exposure and damage will be driven more by the increasing extent of coastal flooding occurring because of a combination of subsidence and SLR.

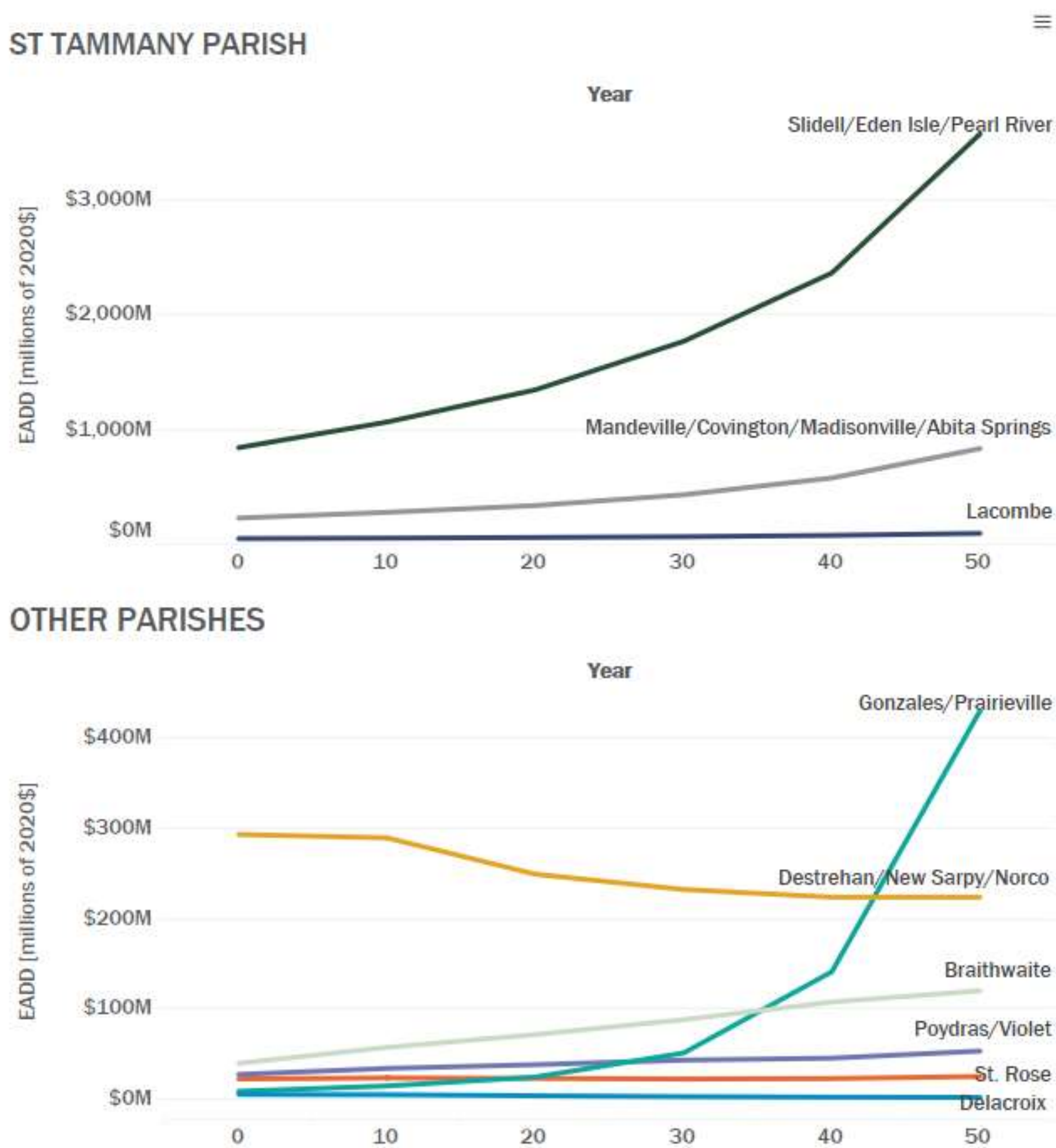

Figure 7. EADD in selected Pontchartrain/Breton region communities over the 50-year simulation period under the higher scenario.

Finally, the model simulations show relatively little change in projected flood depths or EADD under either SLR scenario within the enclosed east bank HSDRRS, including the City of New Orleans and portions of the Greater New Orleans Metropolitan region. The 2023 Coastal Master Plan assumes that planned improvements to the levee system will be implemented by USACE to keep pace with SLR and subsidence. These improvements are sufficient to prevent flooding due to levee overtopping and failure during a 1% annual chance flood event in both environmental scenarios through the 50-year analysis period. If these improvements did not occur or were delayed, depth and damage projections within HSDRRS could increase dramatically in either or both scenarios by Year 50.

2.3 STORM SURGE AND WAVES RESULTS

Prior to conducting the FWOA simulations, the Pontchartrain/Breton region of the ADCIRC model was updated to include WSLP due to be constructed by USACE. Topography and bathymetry are shown in Figure 8. Additionally, initial conditions land use was interpolated to the model to construct Manning's n (Figure 9), directional wind reduction (Figure 10), and surface canopy coefficients (Figure 11).[3] Updated data is interpolated to the ADCIRC model from ICM every 10 years. This section shows how the model changes in Year 30 and Year 50 and the associated simulation results.

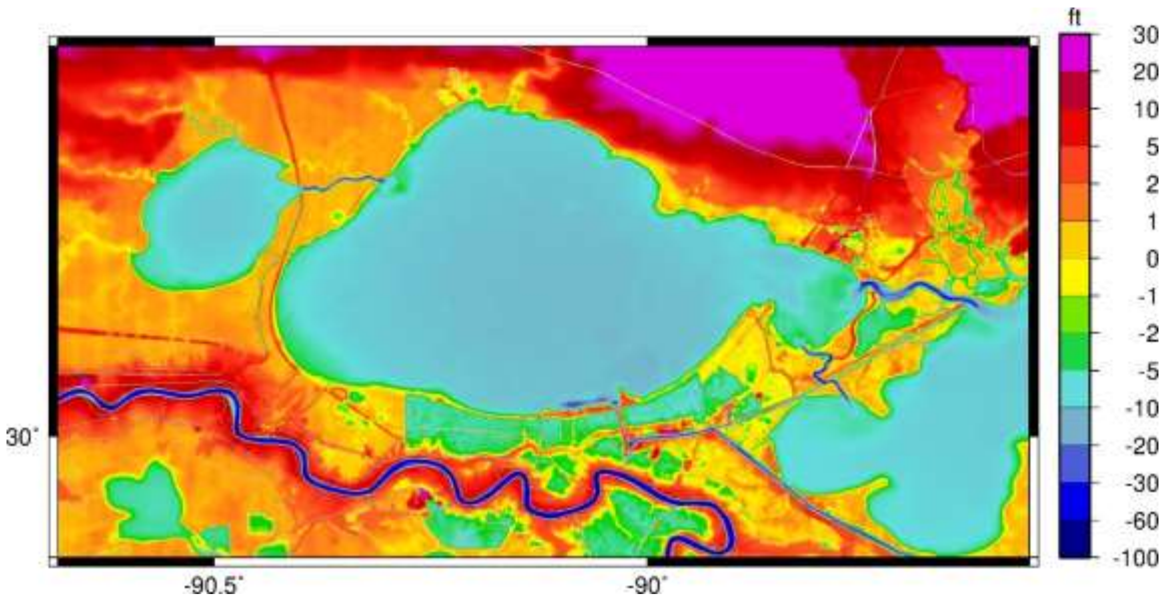

Figure 8. Topography and bathymetry (feet, NAVD88) in ADCIRC at Year 0.

[3] See Cobell and Roberts (2021) for more information on these input parameters and their effects on storm surge propagation in the ADCIRC model.

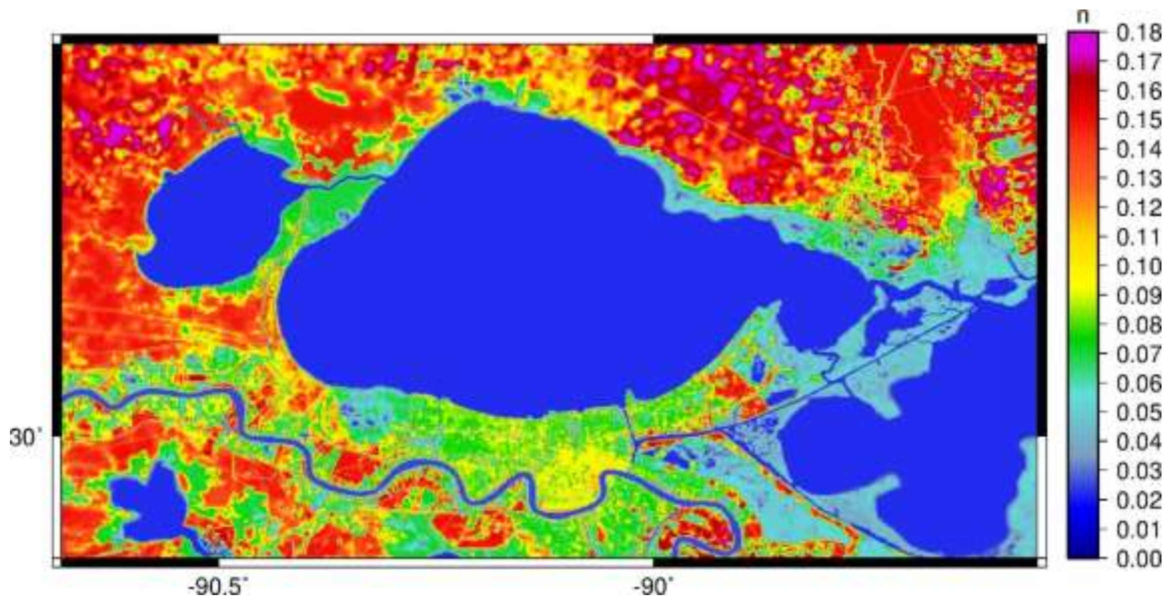

Figure 9. Manning's n coefficient in ADCIRC at Year 0.

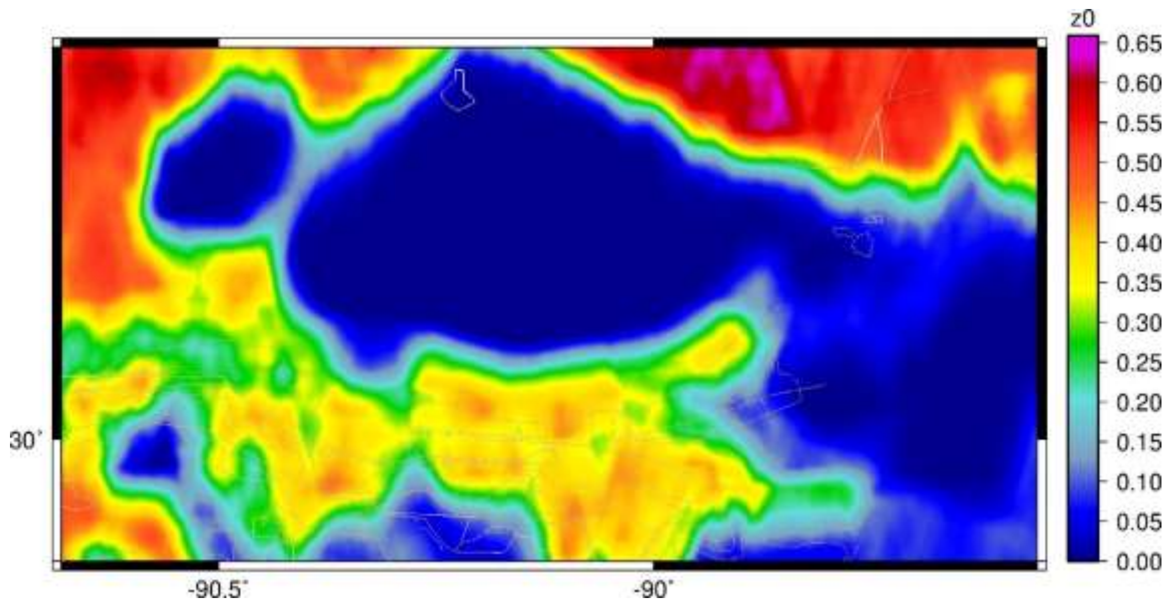

Figure 10. Directional wind reduction coefficient for a wind blowing from the south in ADCIRC at Year 0.

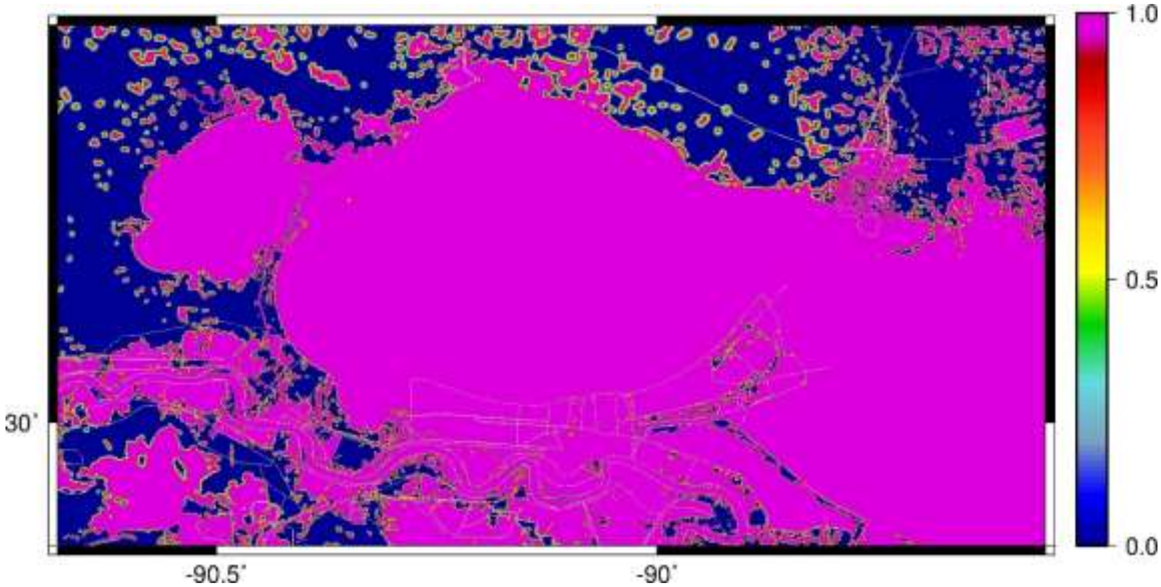

Figure 11. Surface canopy coefficient in ADCIRC at Year 0.

Storm 283 is used as an example to describe impacts within this basin, particularly the nonlinear response due to the basin geometry near Braithwaite. Storm 283 makes landfall near Port Fourchon, but counterclockwise winds push surge toward the southern portion of St. Bernard Parish and Braithwaite. The peak surge elevation and peak wave height in Year 0 for Storm 283 are shown in Figure 12 and Figure 13.

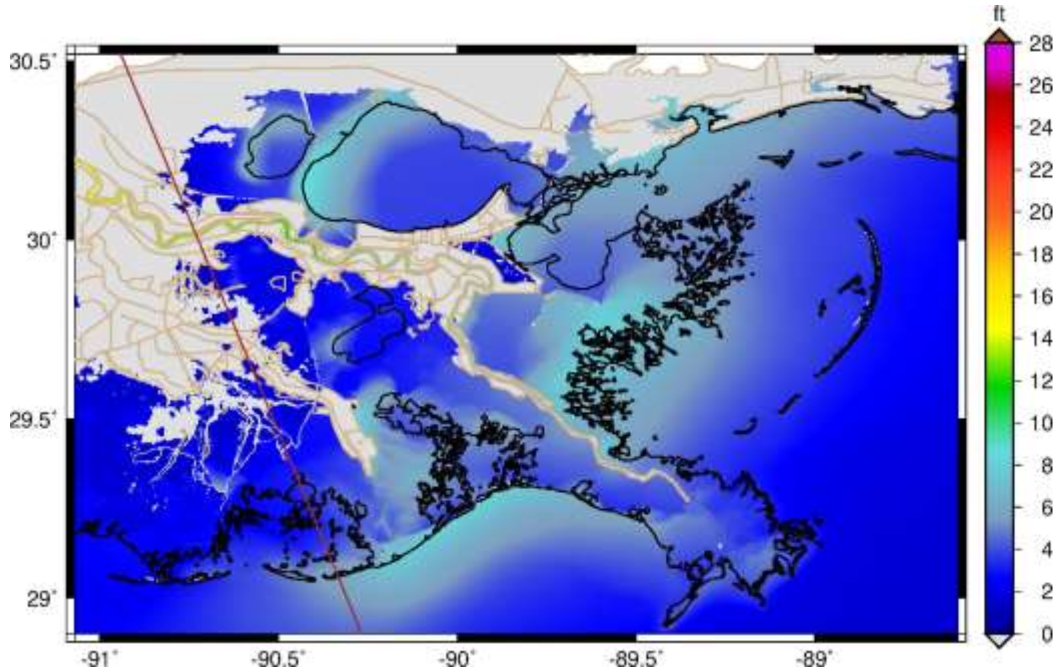

Figure 12. Peak water surface elevation for Storm 283 simulated in Year 0.

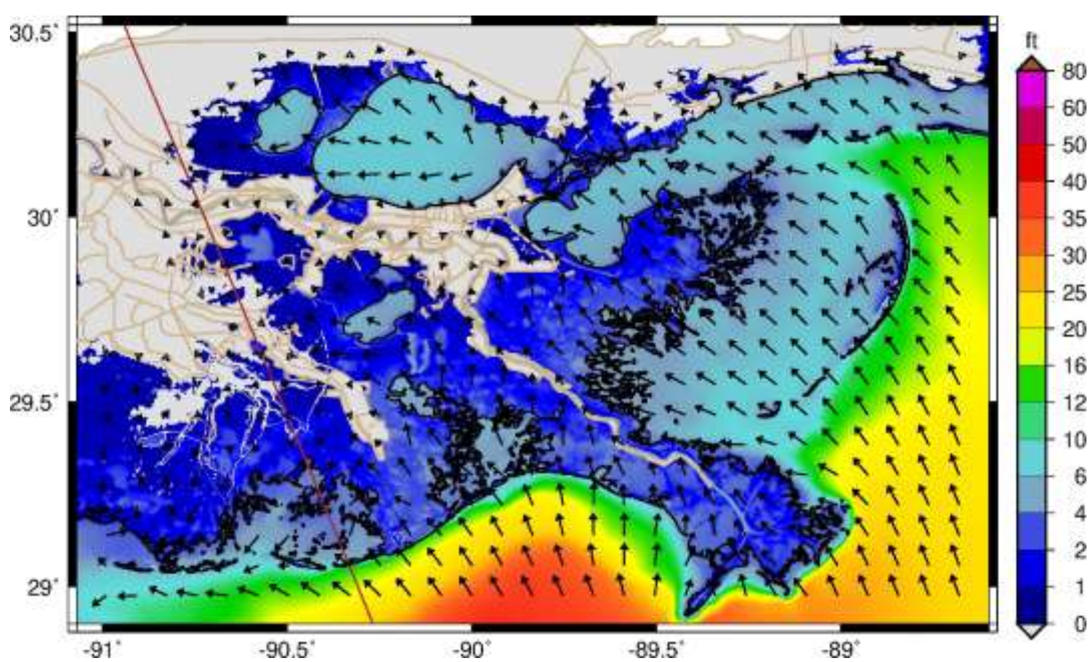

Figure 13. Peak wave height (feet) for Storm 283 in Year 0.

LOWER SCENARIO

In Year 30, ICM shows slight increases in elevation of marsh areas which corresponds to slightly higher friction values (both Manning's n and directional wind reduction), shown in Figure 14 through Figure 16.

In Year 50, the ICM continues to show increased elevations through many of the marshy areas of the model (Figure 17). However, Manning's n and directional wind reduction coefficients (Figure 18, Figure 19) have begun to show reductions in the frictional characteristics of these marshes due to the land classes exhibited by the ICM.

Additional details about the changes in topography, bathymetry, and land use characteristics can be found in (White, 2023).

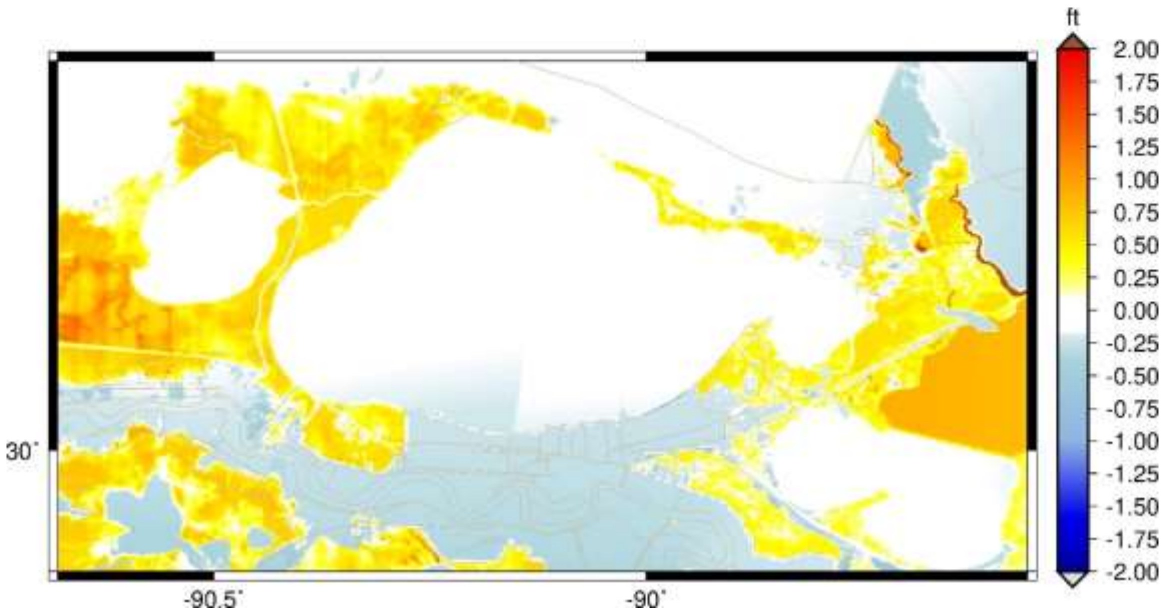

Figure 14. Change in topography and bathymetry in ADCIRC in the lower scenario for Year 30.

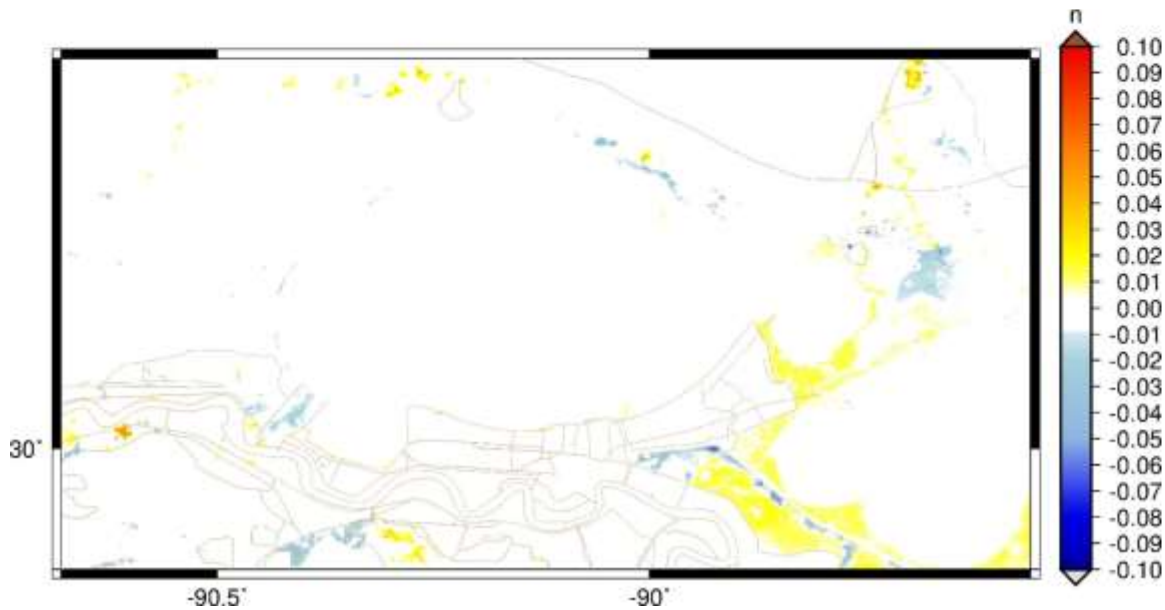

Figure 15. Change in Manning's n coefficient in ADCIRC in the lower scenario for Year 30.

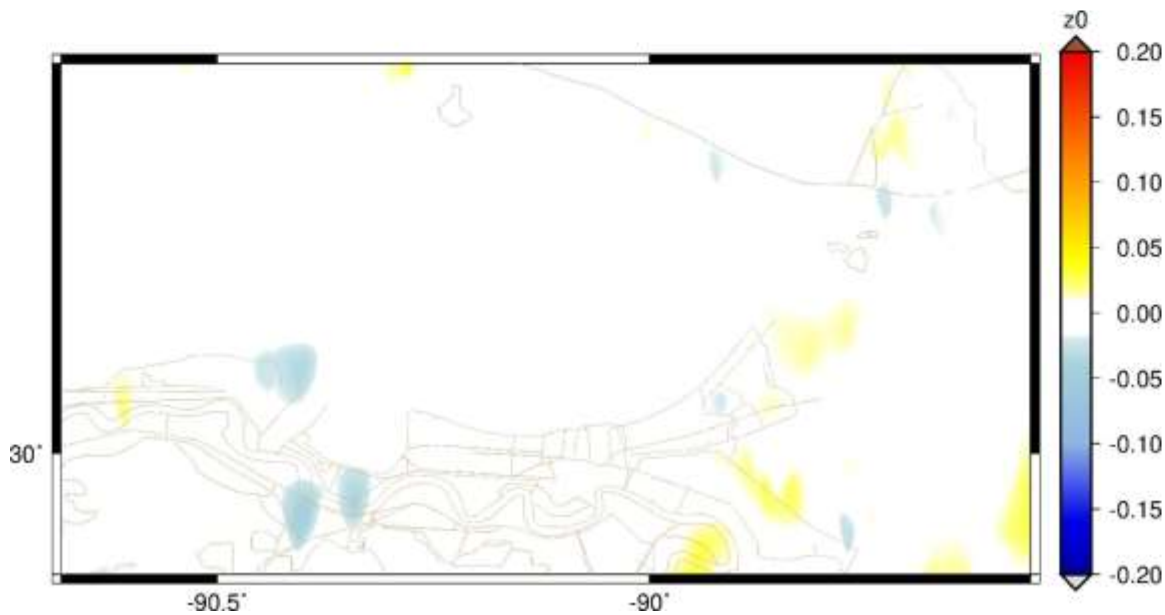

Figure 16. Change in directional wind reduction in ADCIRC in the lower scenario in Year 30.

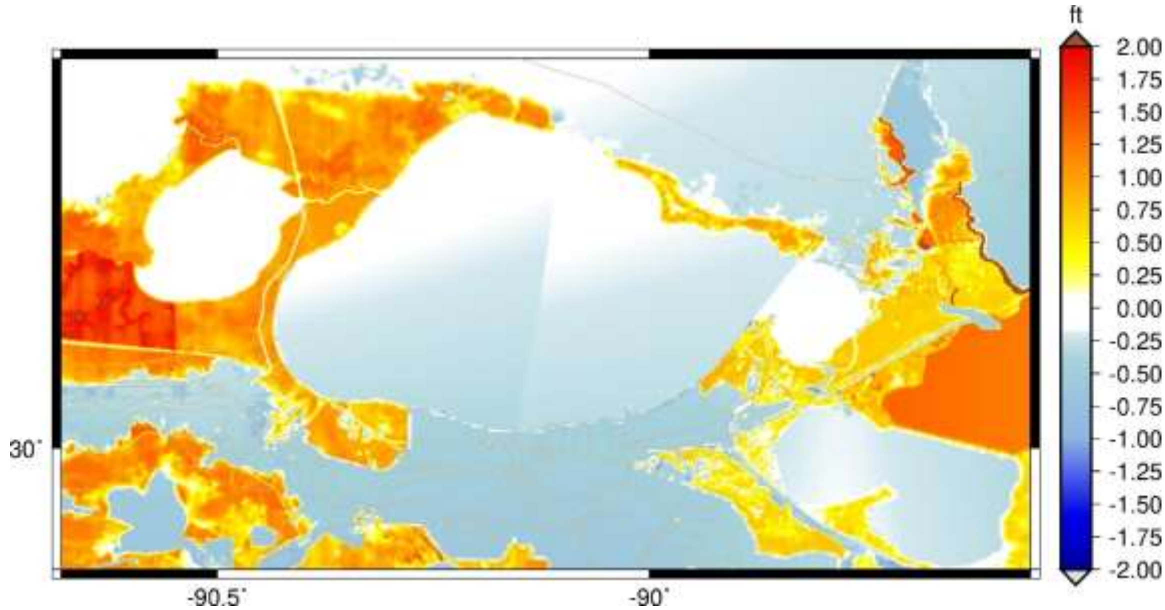

Figure 17. Change in topography and bathymetry in ADCIRC in the lower scenario for Year 50.

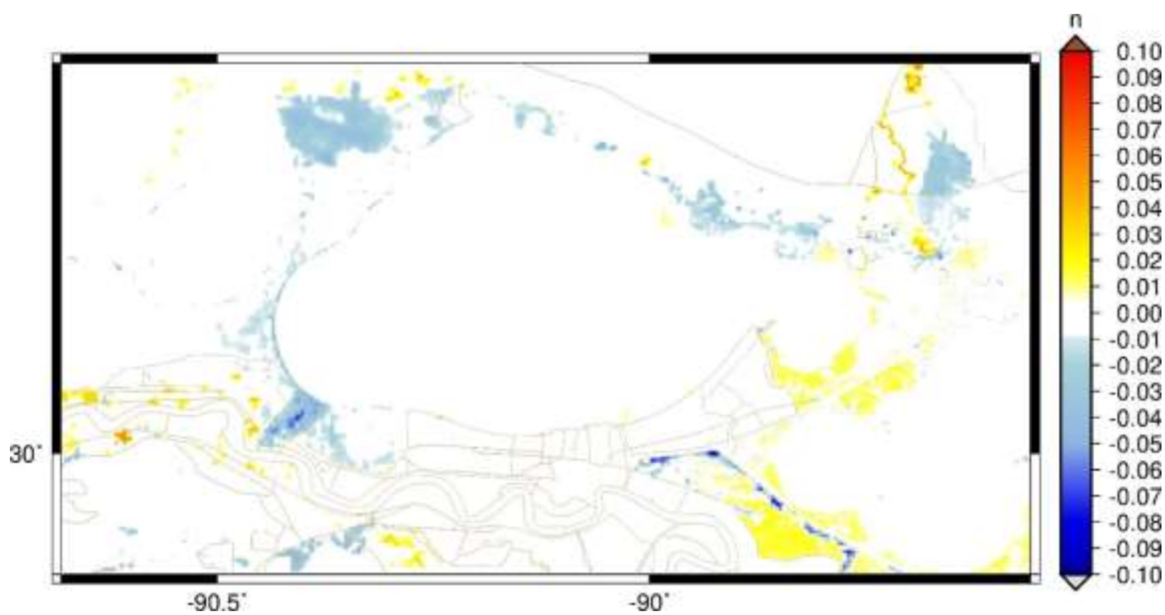

Figure 18. Change in Manning's n coefficient in ADCIRC in the lower scenario for Year 50.

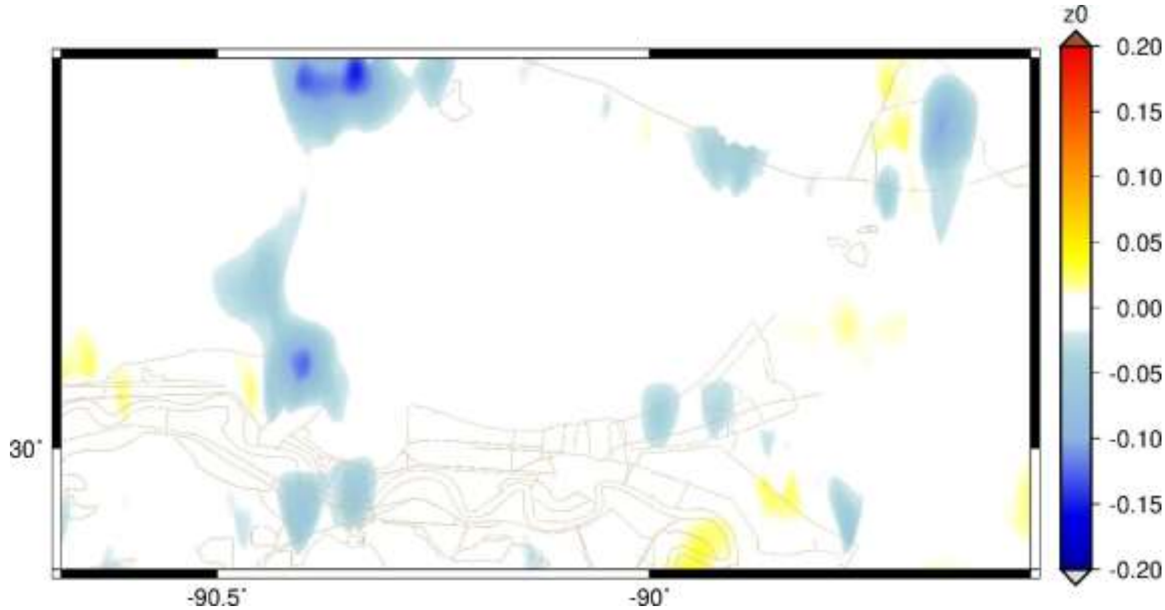

Figure 19. Change in directional wind reduction in ADCIRC in the lower scenario in Year 50.

Changes in storm surge and waves are most influenced by the SLR increment rather than changes to topography or frictional characteristics. Figure 20 and Figure 22 show the change in peak water level in Year 30 and Year 50, and Figure 21 and Figure 23 show the change in peak wave height in each year, respectively. The offshore color shown in the plots aligns with the SLR increment. Colors warmer than this offshore value indicate a nonlinear response where the change in the peak water surface elevation is greater than that of the SLR increment.

The geometry of the Breton Sound acts as a funnel where the HSDRRS system levees on the south side of St. Bernard Parish and the Mississippi River levees focus surge toward Braithwaite. Another trend in this region is the area wetted by this storm on the western edge of Lake Maurepas moves further westward toward Gonzales/Prairieville. This area has relatively little change in frictional parameters and shows an increase in topographic elevation; however, the SLR increment is still the most influential factor in increasing both water levels and wetted area. Wave heights change as a function of increased water depth. Near the Mid Breton Sediment Diversion, wave heights stay the same or decrease even though the peak water level increases because of land building.

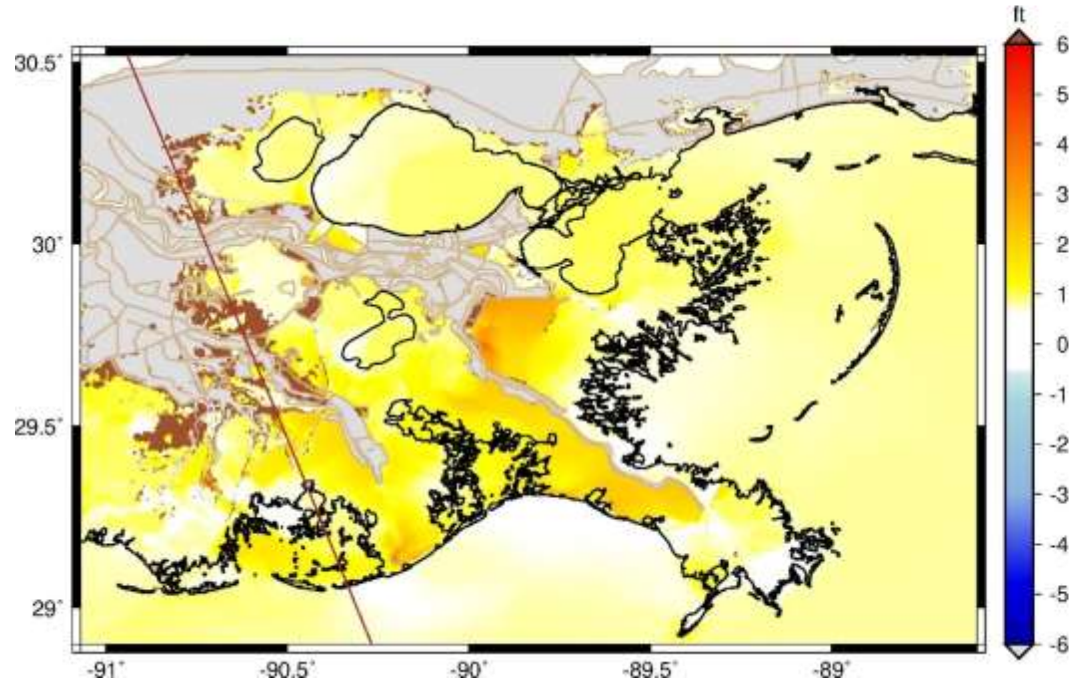

Figure 20. Change in peak water surface elevation between Year 30 and Year 0 in the lower scenario.

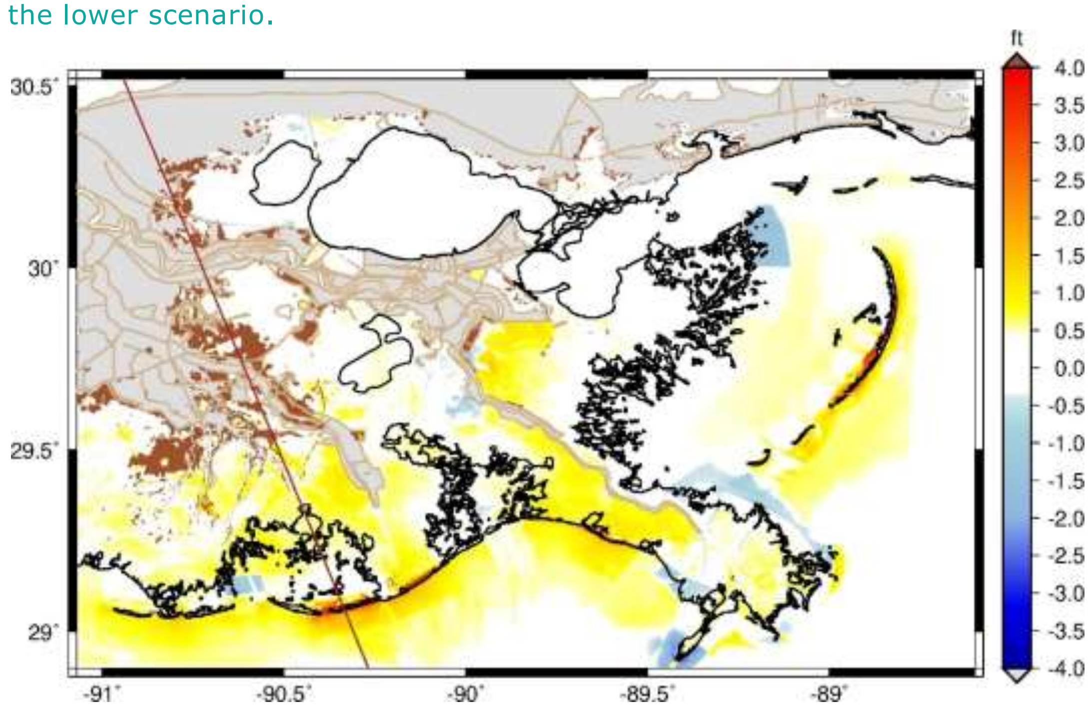

Figure 21. Change in peak wave height between Year 30 and Year 0 in the lower scenario.

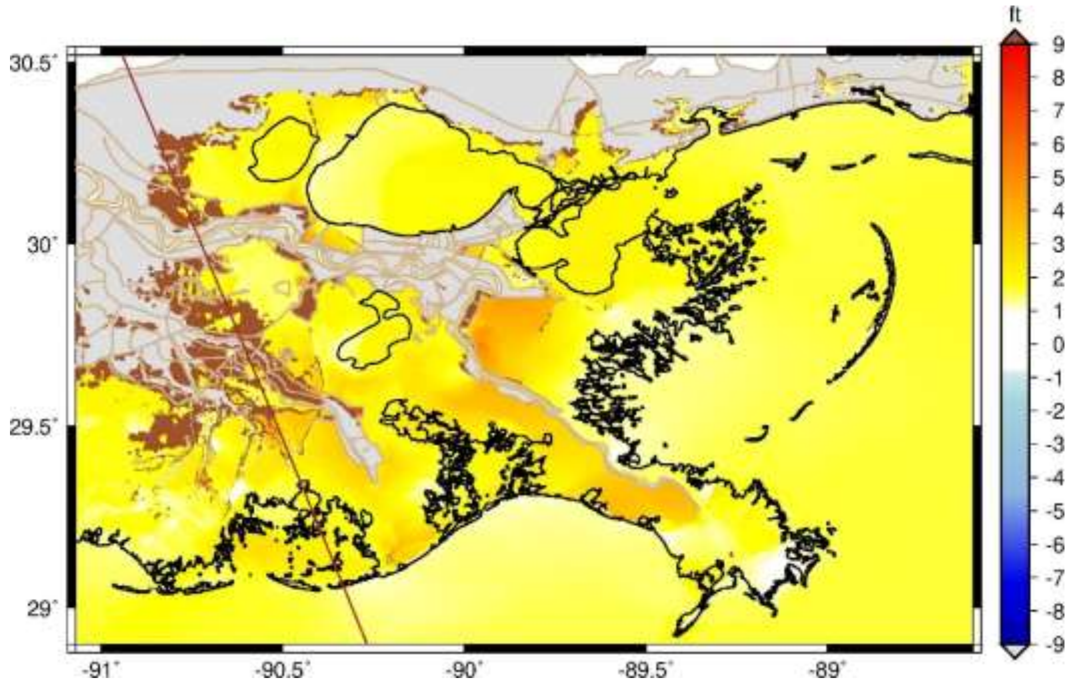

Figure 22. Change in peak water surface elevation between Year 50 and Year 0 in the lower scenario.

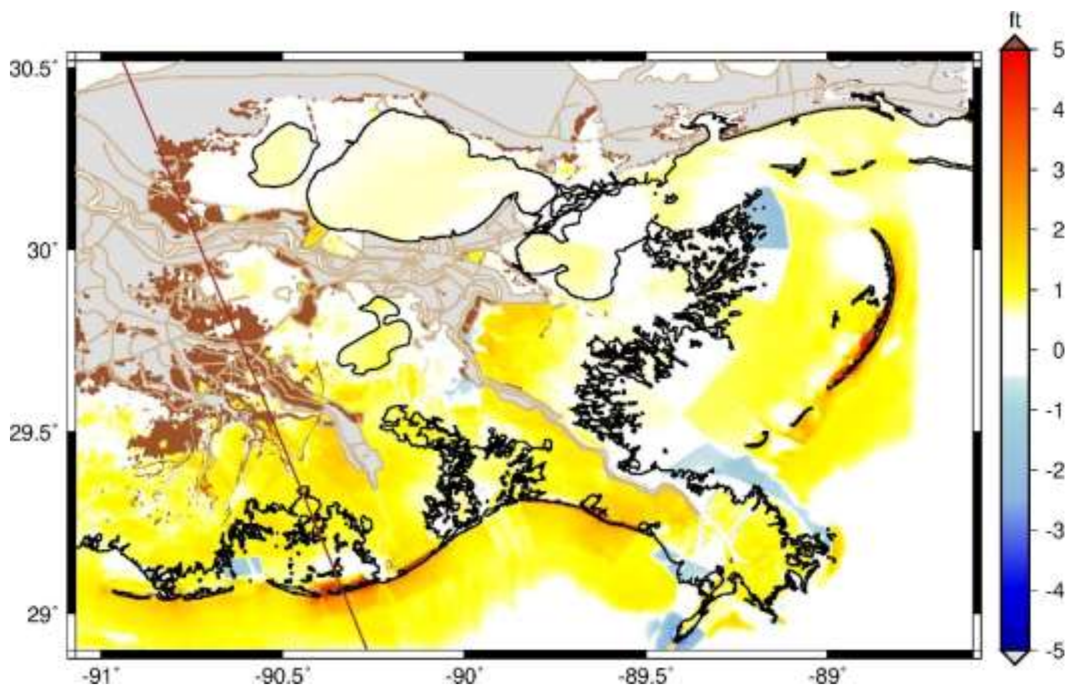

Figure 23. Change in peak wave height between Year 50 and Year 0 in the lower scenario.

HIGHER SCENARIO

Until Year 30, trends in the higher scenario are similar to those in the lower scenario. Changes to model topography and frictional parameters are shown in Figure 24 (Year 30) and Figure 26 (Year 50). However, by Year 50, there is no longer an increase in frictional parameters, as there had been in prior years, due to the land use classes exhibited by the ICM. Additional details about the changes in topography, bathymetry, and land use characteristics can be found in White et al. (2023).

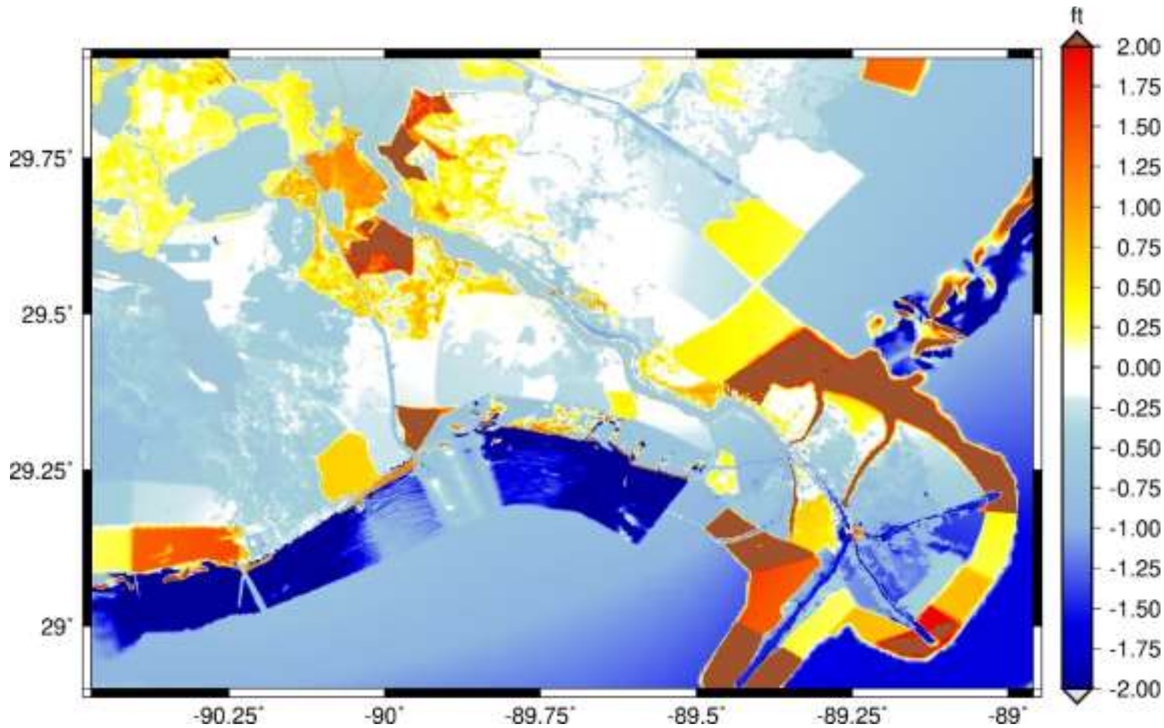

Figure 24. Change in topographic elevation in the higher scenario in Year 30.

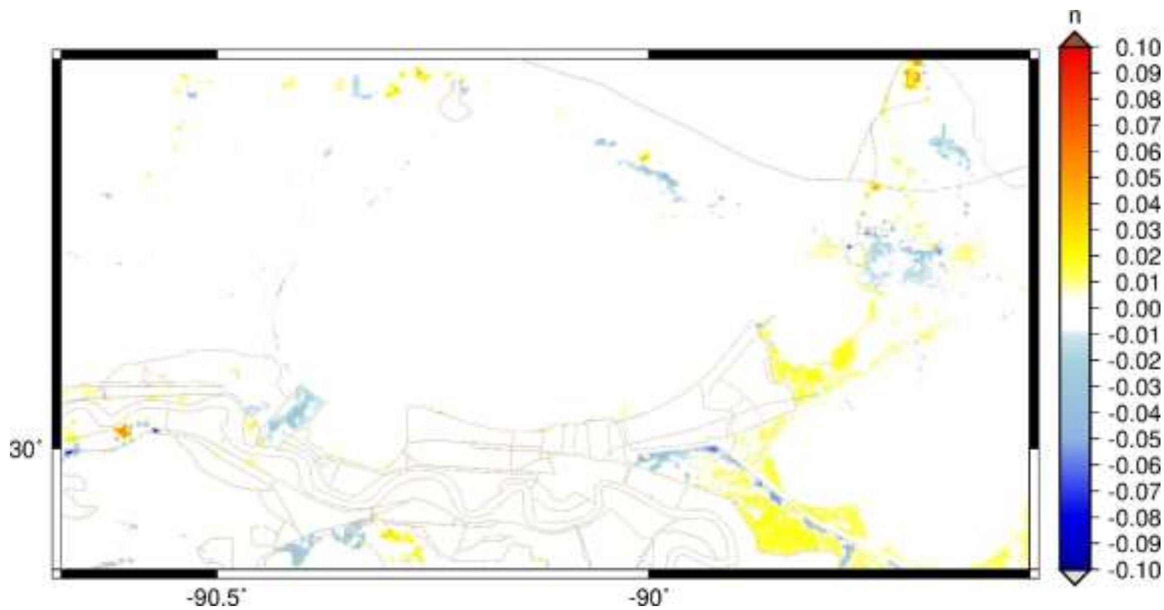

Figure 25. Change in Manning's n coefficient in the higher scenario in Year 30.

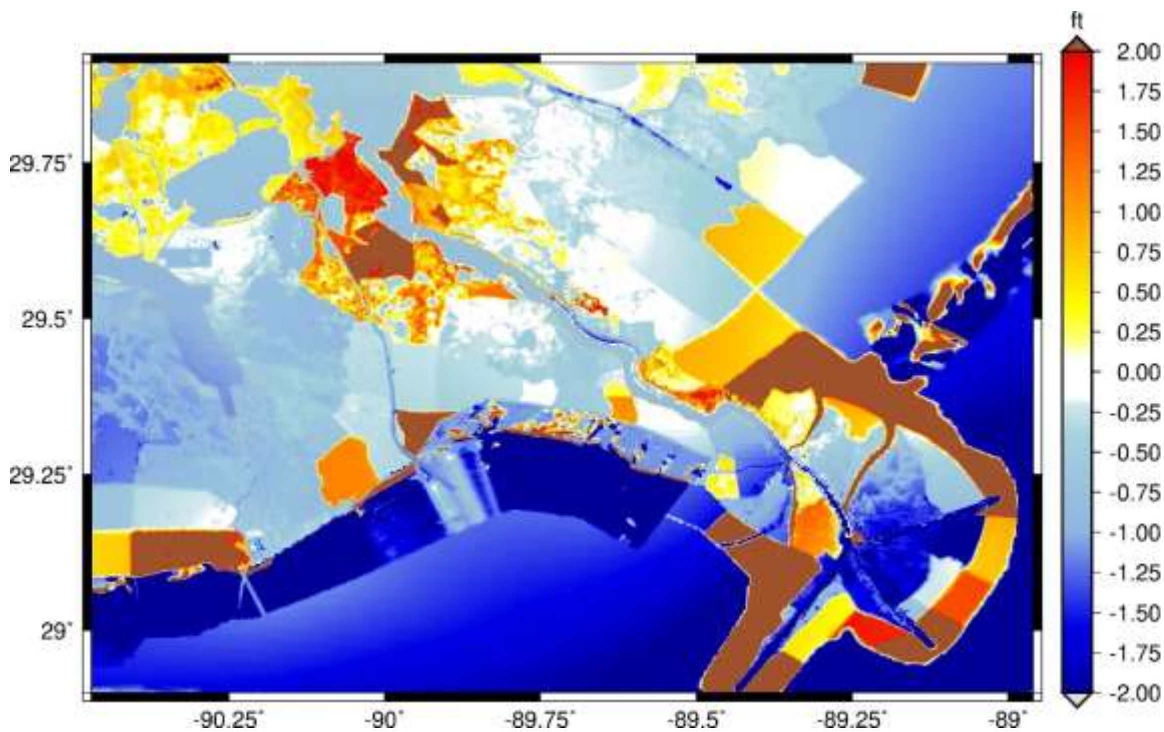

Figure 26. Change in topographic elevation in the higher scenario in Year 50.

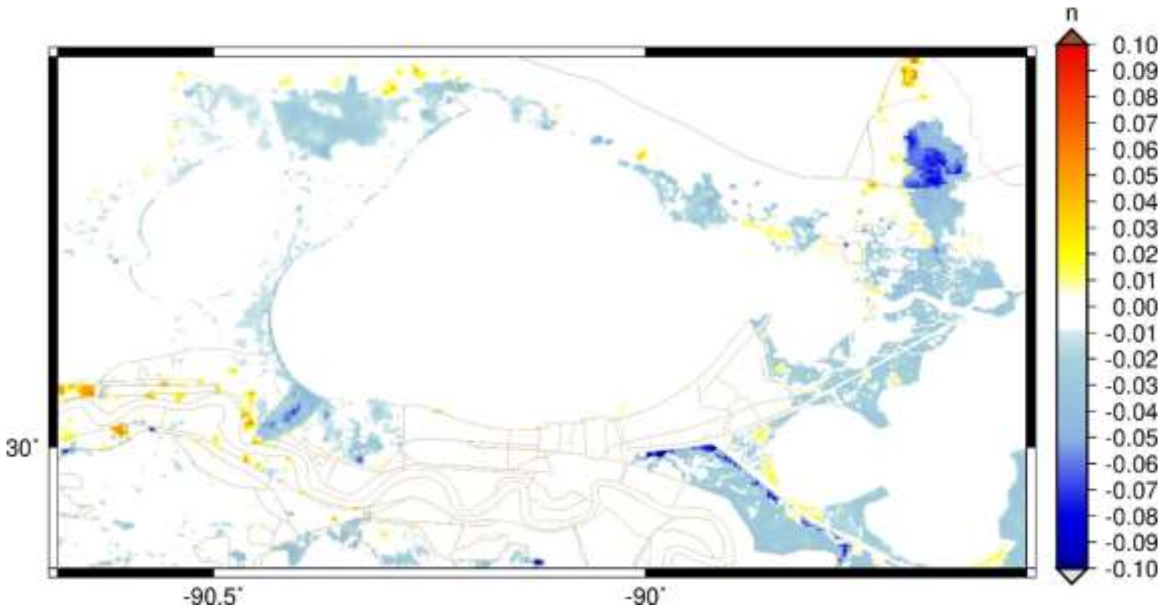

Figure 27. Change in Manning's n coefficient in the higher scenario in Year 50.

Like the lower scenario, changes in peak water surface elevation are most influenced by SLR rather than changes in topography or frictional characteristics. The higher rate of SLR leads to greater changes in peak water surface elevations and peak wave heights. Figure 28 and Figure 30 show the change in peak water level in Year 30 and Year 50 and Figure 29 and Figure 31 show the change in peak wave height. The area near Braithwaite continues to show surge amplification, and the west shore of Lake Maurepas continues to show newly inundated areas. Like the lower scenario, wave heights are controlled by changes in total water depth.

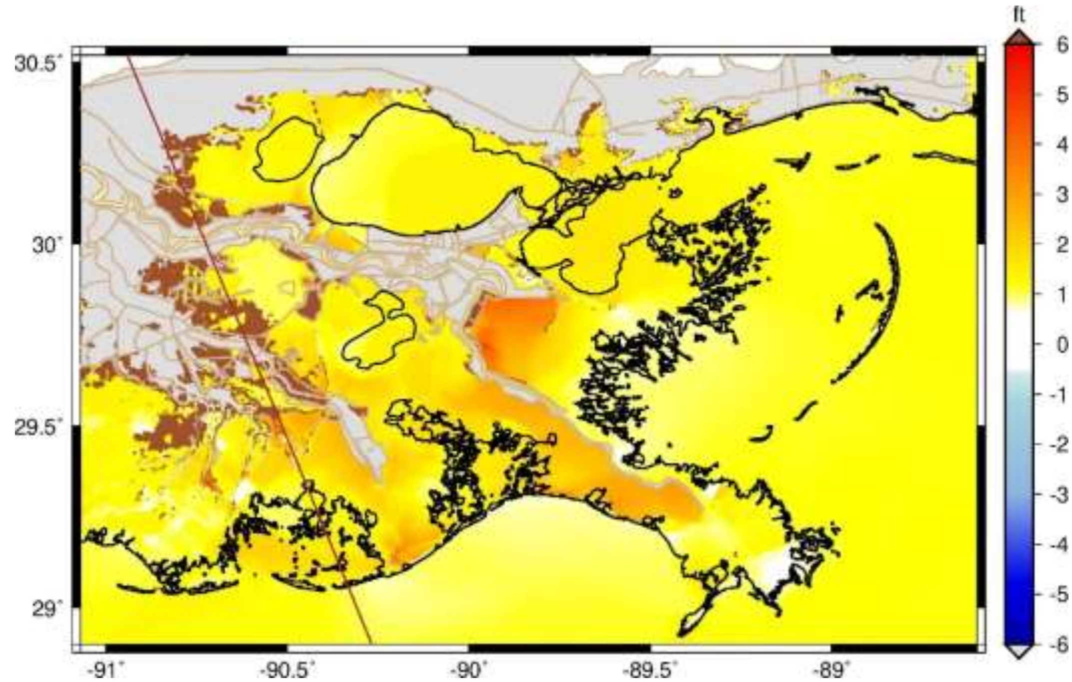

Figure 28. Change in peak water surface elevation between Year 30 and Year 0 in the higher scenario.

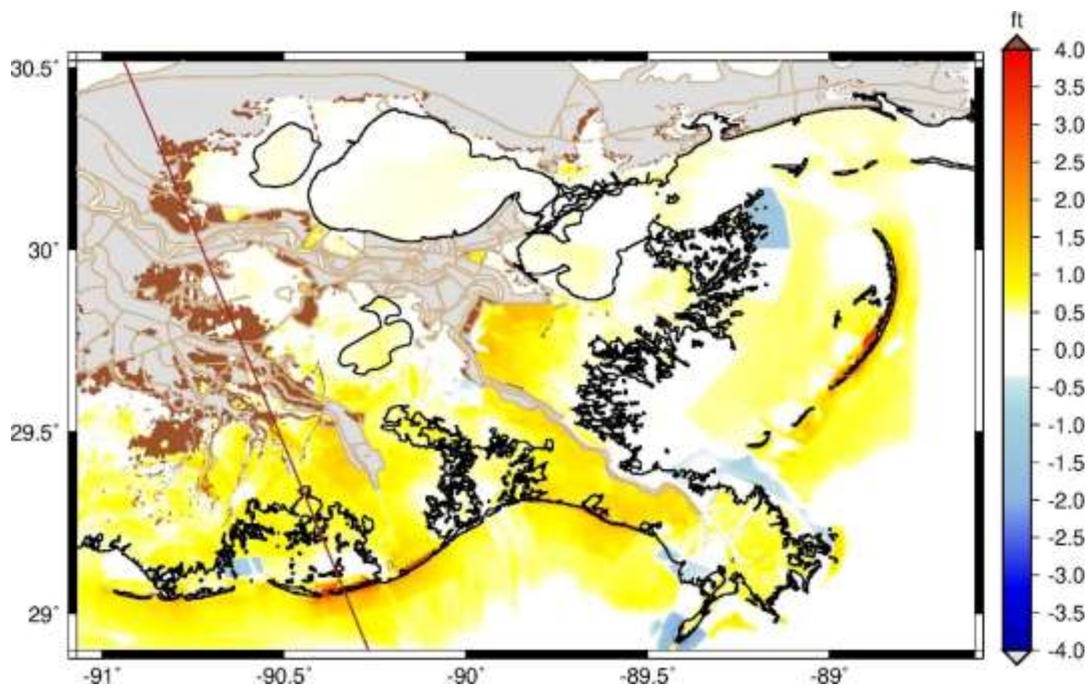

Figure 29. Change in peak wave height between Year 30 and Year 0 in the higher scenario.

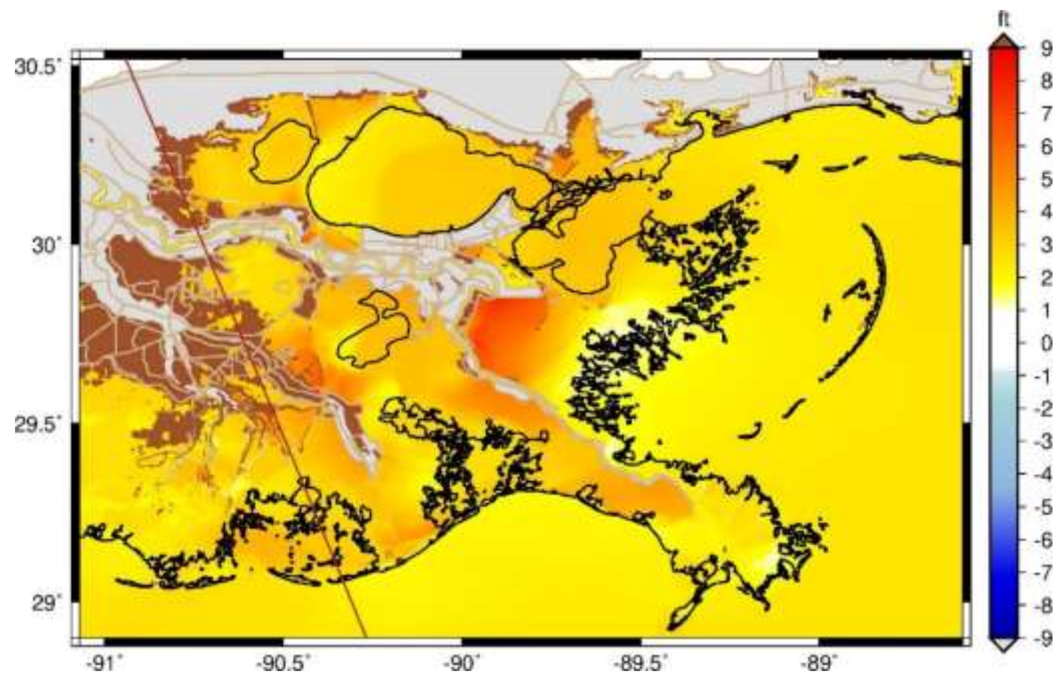

Figure 30. Change in peak water surface elevation between Year 50 and Year 0 in the higher scenario.

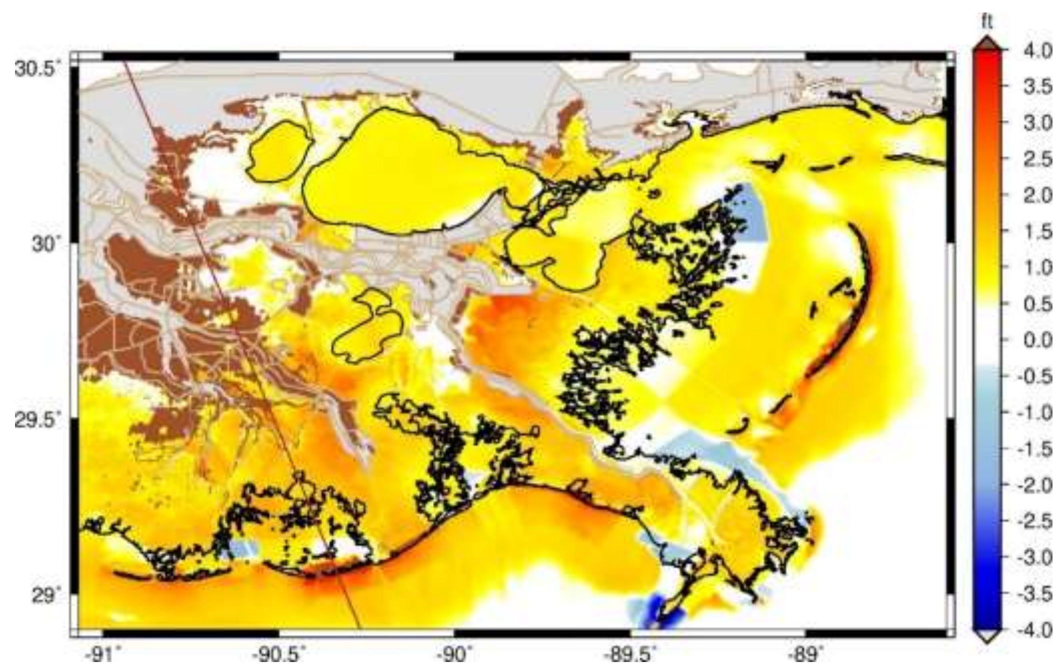

Figure 31. Change in peak wave height between Year 50 and Year 0 in the higher scenario.

2.4 FLOOD DEPTH PROJECTIONS

LOWER SCENARIO

The Pontchartrain/Breton region is home to a significant fraction of the total population of coastal Louisiana, including the City of New Orleans and population centers in St. Tammany Parish such as Slidell, Covington, and Mandeville. Plaquemines and St. Bernard parishes make up the southeastern edge of the region and have communities both in- and outside of enclosed levee protection systems, while Orleans Parish is almost entirely contained within HSDRRS.

Figure 32 shows the 10% annual chance (1 in 10-year) flood depths — also referred to as the 10% AEP — projected for years 20-50, with each pane showing one decade. Depths in Breton Sound and east of the lake itself are already greater than 10 feet at this AEP. In the early decades of the simulation, while the northern and eastern shores of the lake show 10% AEP depths of 7-10 feet along the coastline and 4-7 feet extending further inland, especially west towards Lake Maurepas. In densely populated areas within enclosed protected systems, including portions of Plaquemines and St. Bernard parishes within HSDRRS (e.g., Braithwaite) and Laplace and Reserve towards the western lakeshore, lower levels (1-4 feet) of flooding are observed at the 10% AEP largely driven by rainfall within enclosed protected systems. These rainfall-driven flood volumes are lower when assuming 100% pumping capacity (not shown) versus the 50% capacity presented as a default scenario[4] in this document.

[4] The CLARA model's calculated peak water levels in areas enclosed by structural protection systems allow for scenario-based assumptions about water volumes pumped out of the polder during an event. Pumps are assumed by default to operate at only 50% of rated capacity to account for the possibility of being overwhelmed during major overtopping or breach events.

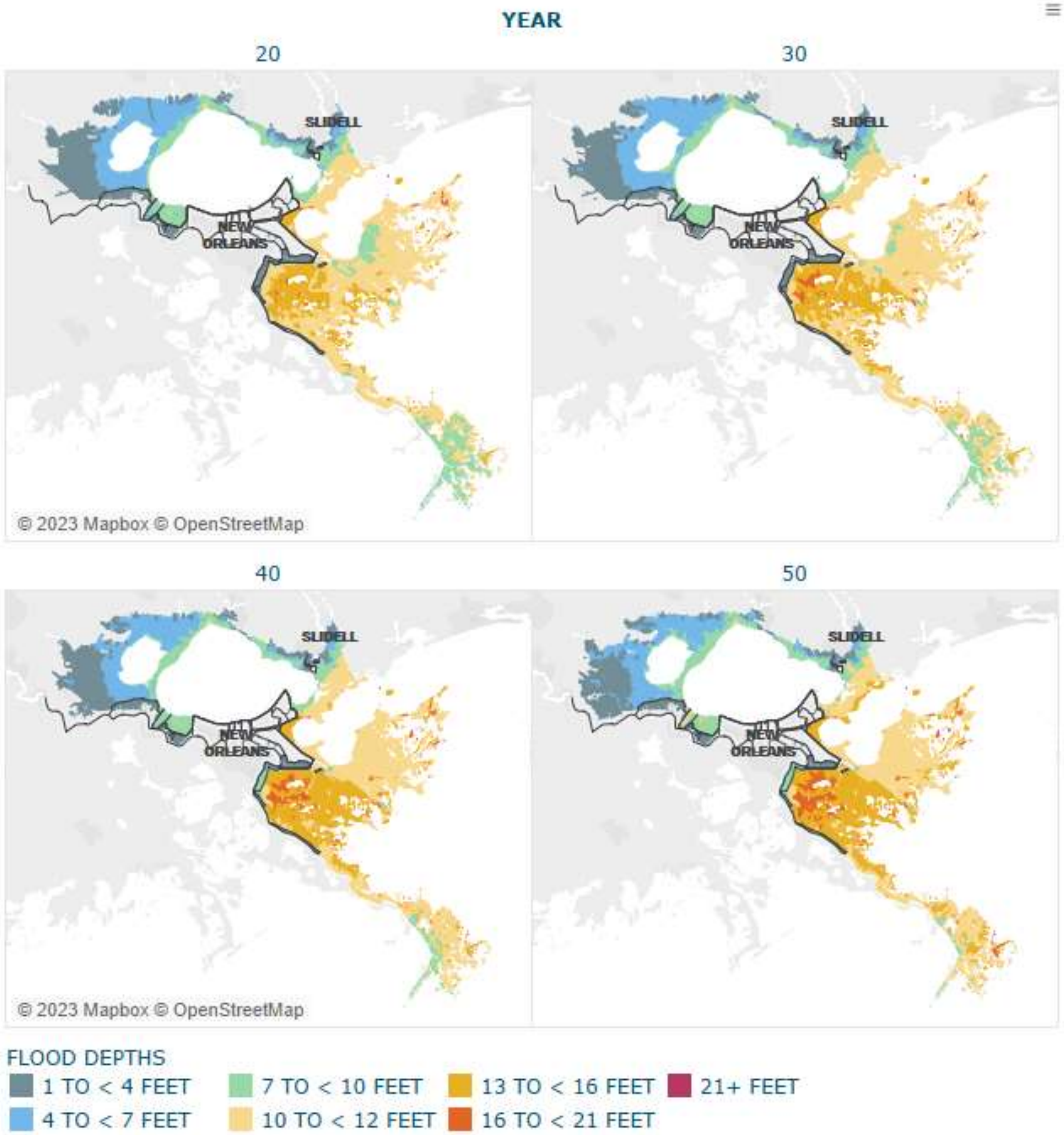

Figure 32. 10% annual chance (1 in 10-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Flood depths increase modestly in magnitude and extent when projected forward in a FWOA. Figure 33 shows the change in 10% annual chance flood depths in the lower scenario. We observe depth increases in Breton Sound of 1-2 feet in early decades, with the extent of flooding extending further northward into St. Tammany Parish and westward into Livingston and Tangipahoa parishes. By Year 50, nearly the entire basin shows depth increases of at least 1-2 feet, except for enclosed protected areas such as east bank HSDRRS and with the new WSLP levee system. A notable exception is the Braithwaite polder, where 10% AEP flooding is driven largely by rainfall in initial conditions (not shown), but over time experiences increasing overtopping due to the added relative sea level rise (RSLR) outside of the system in the lower scenario. These effects are especially notable in Year 40 and 50, where the 10% depths increase by 5 or more feet and show substantial flooding (7-10 feet) by the end of the period of analysis.

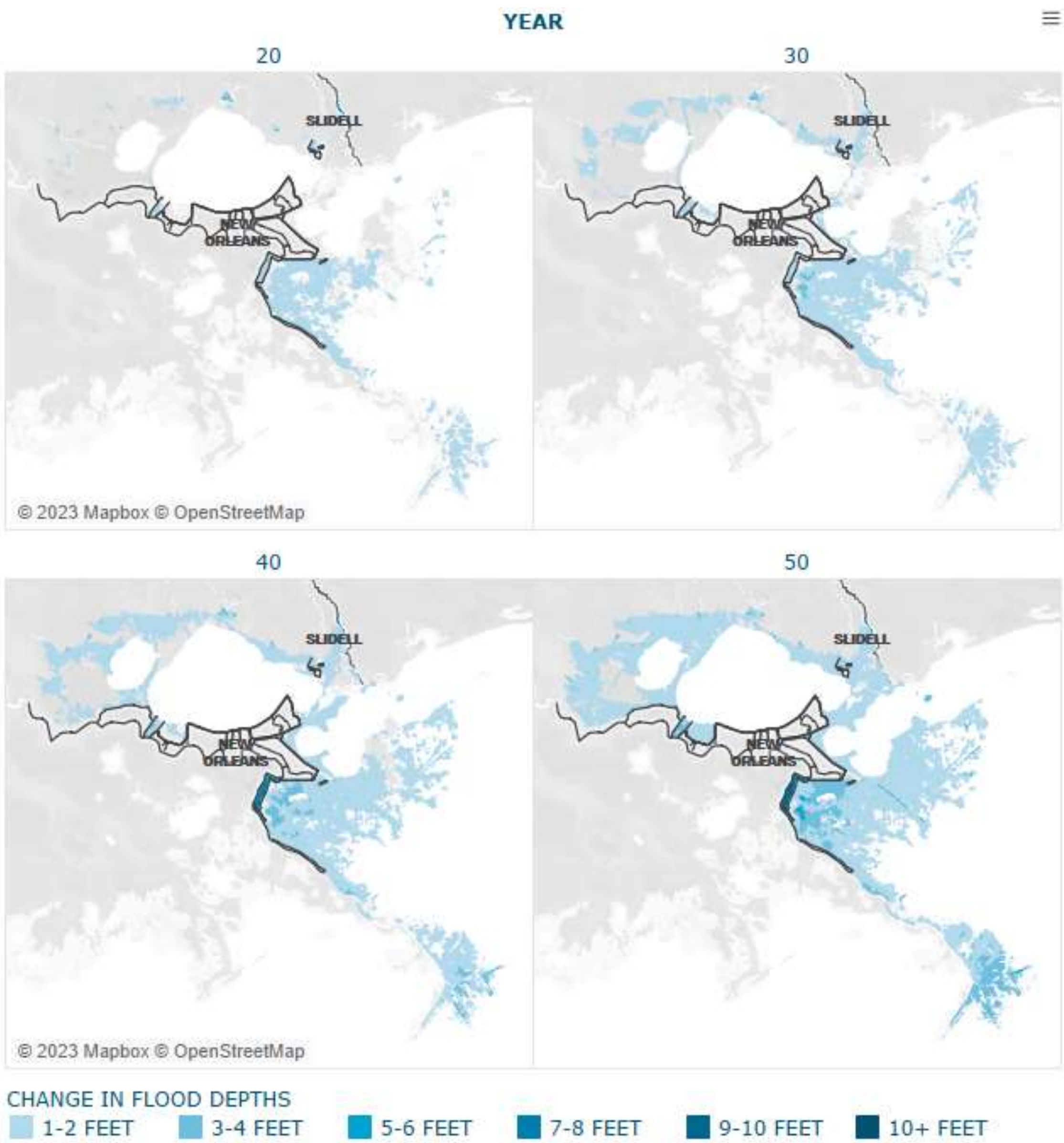

Figure 33. Change in 10% annual chance (1 in 10-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

A 1% annual chance (1 in-100-year) flood would be much more severe across most of the Pontchartrain/Breton region (Figure 34). The “funnel” in Breton Sound shows greater than 20-foot depths for wetland areas outside of the levee system, while Braithwaite would experience 13 or more feet of flooding in a FWOA with the current levees in place. Lake Borgne to the mouth of Lake Pontchartrain is similarly extreme, with 13-16 feet of flooding here and extending towards Slidell at the 1% AEP. These results also show larger areas within east bank HSDRRS with 1-4 feet of flooding — once again driven by rainfall — but most additional affected areas, such as Bayou Sauvage at the eastern end of New Orleans East, are mostly or entirely uninhabited. For communities surrounding Lake Pontchartrain itself, large areas are exposed to 10 or more feet of flooding with a 1% chance of occurring each year.

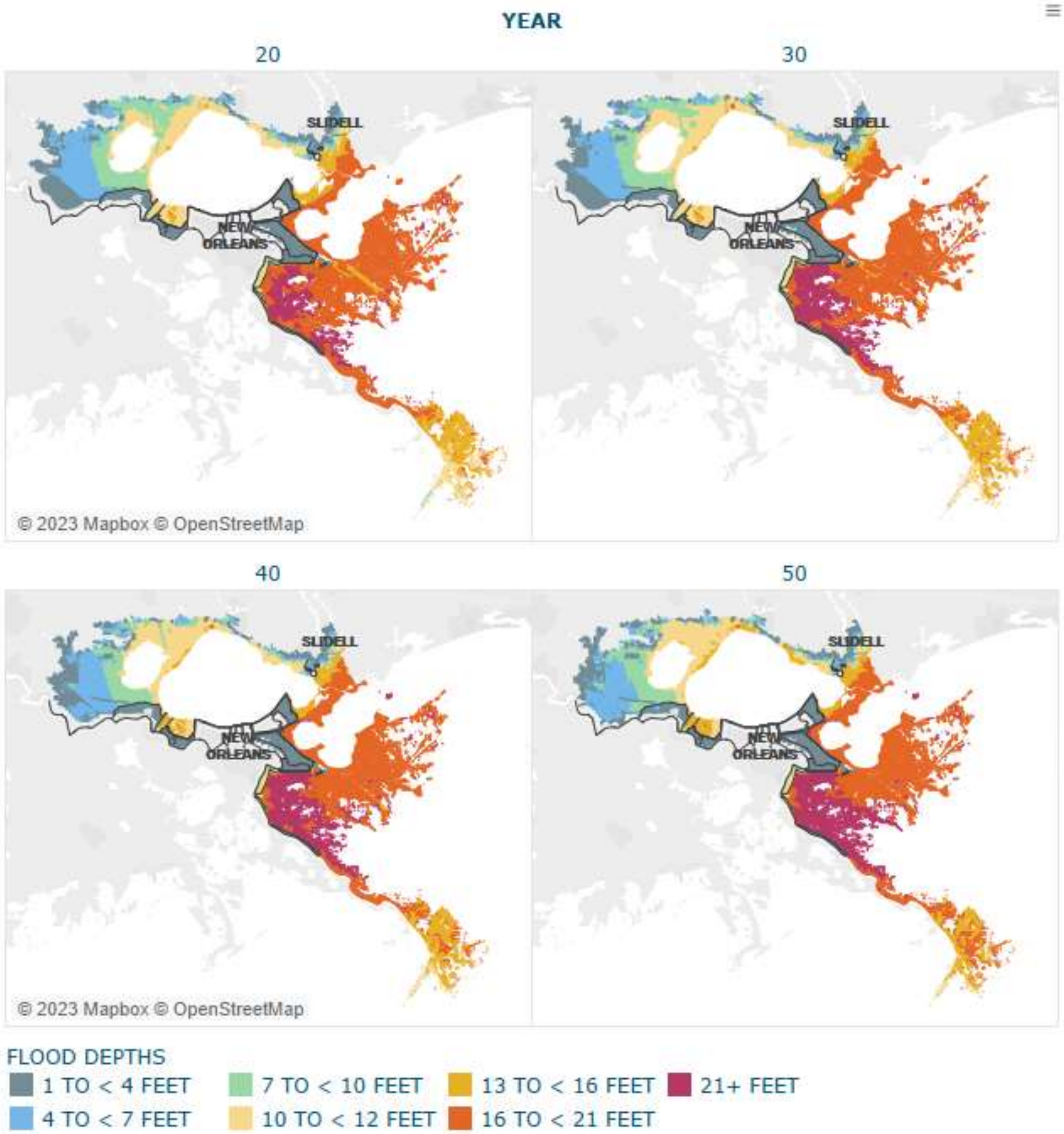

Figure 34. 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Over the 50-year simulation period, 1% AEP flood depths increase modestly across the Pontchartrain/Breton region (Figure 35) in the lower scenario. Most areas experience increases of 1-2 feet — with some of this change coming in areas further upland newly exposed to flooding (e.g., see Year 30, upper right panel), with other areas seeing increased depths over time. By Year 50, 1% AEP flood depths and extent increase across most of the region by 1-2 feet, while selected areas (e.g., Breton, Lower Plaquemines Parish, Gonzales) increase by 3 or more feet.

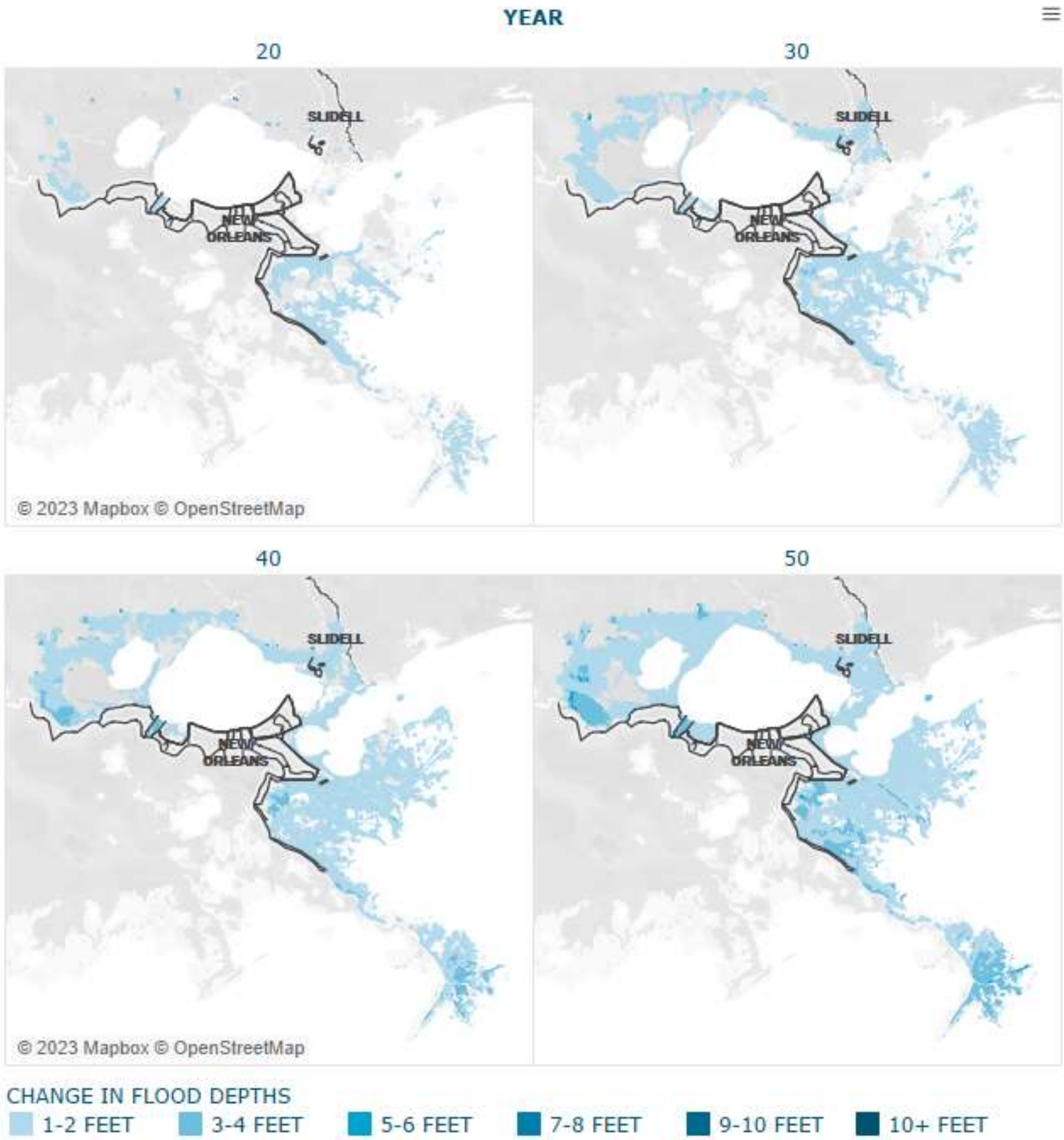

Figure 35. Change in 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

HIGHER SCENARIO

The Pontchartrain/Breton region experiences more rapid changes in the higher scenario, particularly in later decades. This is consistent with the more rapid pace of SLR in this scenario. 10% AEP depths in a higher scenario are shown in Figure 36 below. Patterns are similar to the lower scenario in early decades, but by Year 50 much or most of the Lake Pontchartrain coastline is projected to have a 10% (1 in-10-year) annual chance of experiencing 10 or more feet of flooding. A larger fraction of Breton Sound and the Lake Borgne area shows at least 16 feet of flood depth by Year 50. The polder including Braithwaite is overtopped at the 10% AEP, leading to 10 or more feet of flooding. Other areas within the HSDRRS system show rainfall flooding with similar patterns as in the lower scenario, and the simulation results do not show evidence of east bank HSDRRS overtopping in this AEP and scenario.

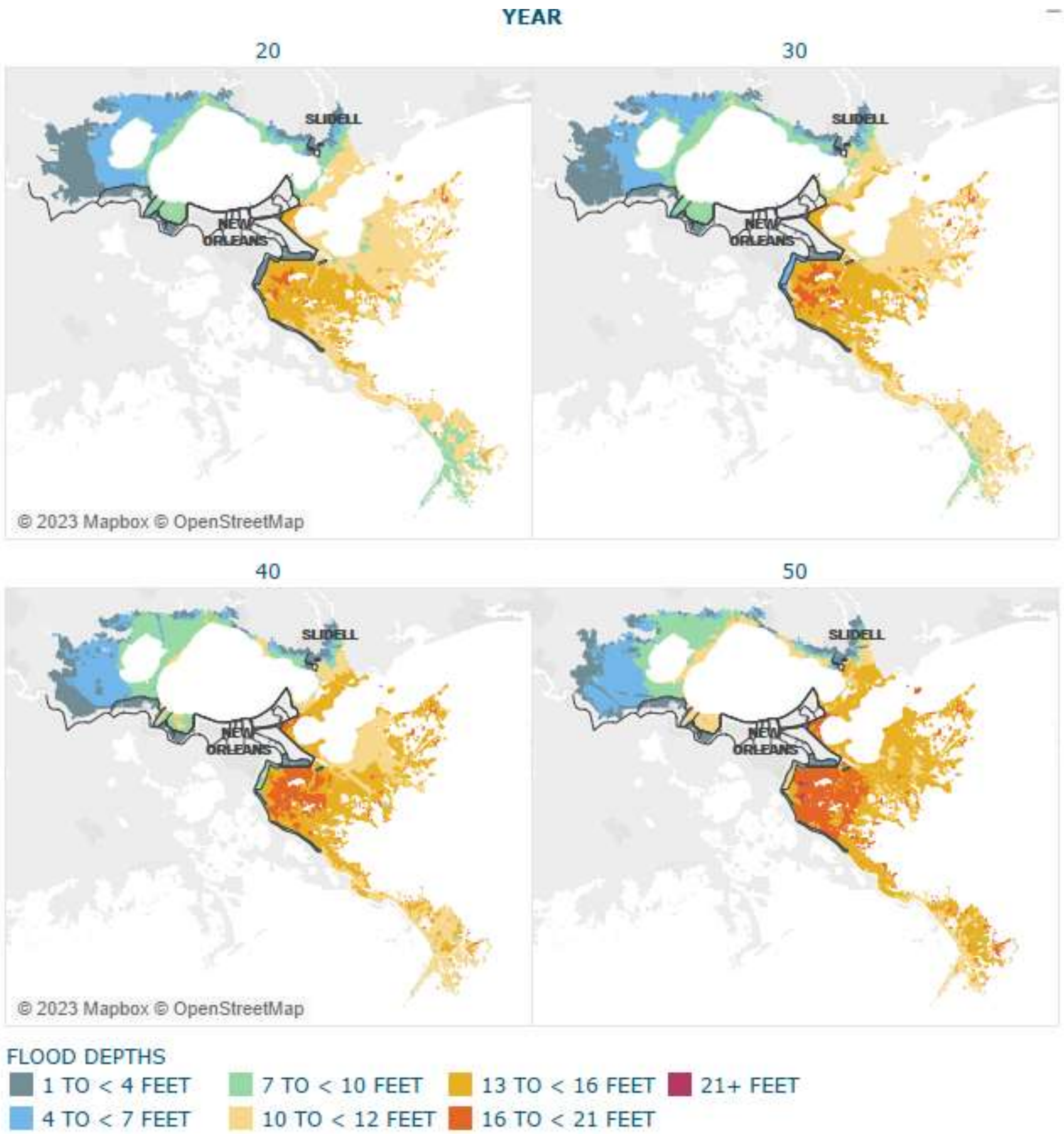

Figure 36. 10% annual chance (1 in 10-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Looking at the change in 10% AEP flood depths (Figure 37), flood extent increases and flood depths increase by 1-2 feet across the basin by Year 30, with more significant change in Braithwaite due to increasing overtopping volumes. By Year 50, the magnitude of depth increases is at least 3-4 feet across much of the region. Breton, Braithwaite, and lower Plaquemines outside of the enclosed levee system once again show the greatest magnitude of change, even starting from a relatively high baseline of flood depths.

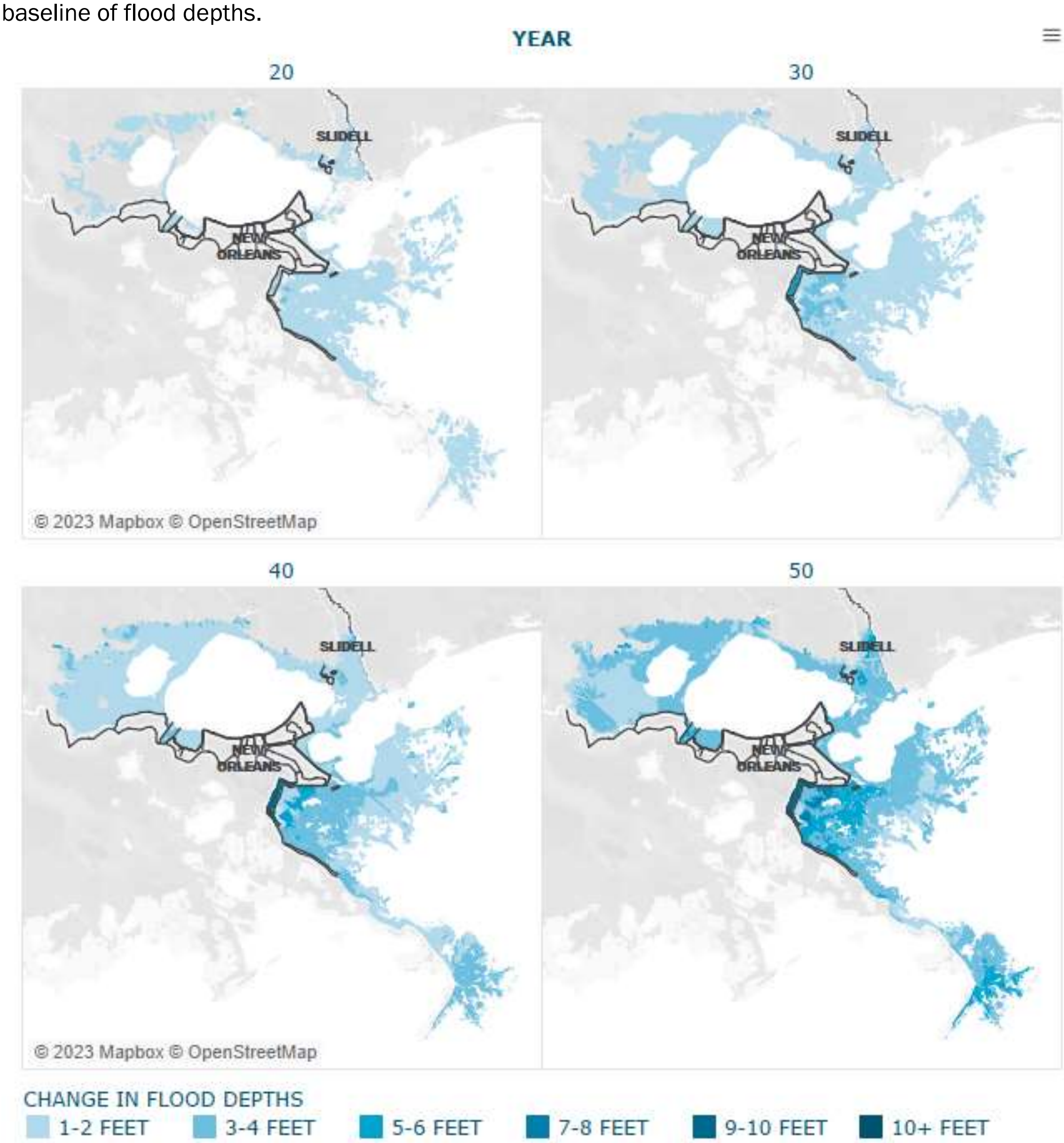

Figure 37. Change in 10% annual chance (1 in 10-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

At the 1% AEP, Pontchartrain/Breton flood depths increase over time to a somewhat greater degree in the higher scenario. 1% AEP depths in Year 20 (Figure 38 below, upper left pane) are already substantial outside of HSDRRS and other enclosed protected areas, and depth increases are observed across the entire basin over the remaining decades (Figure 39).

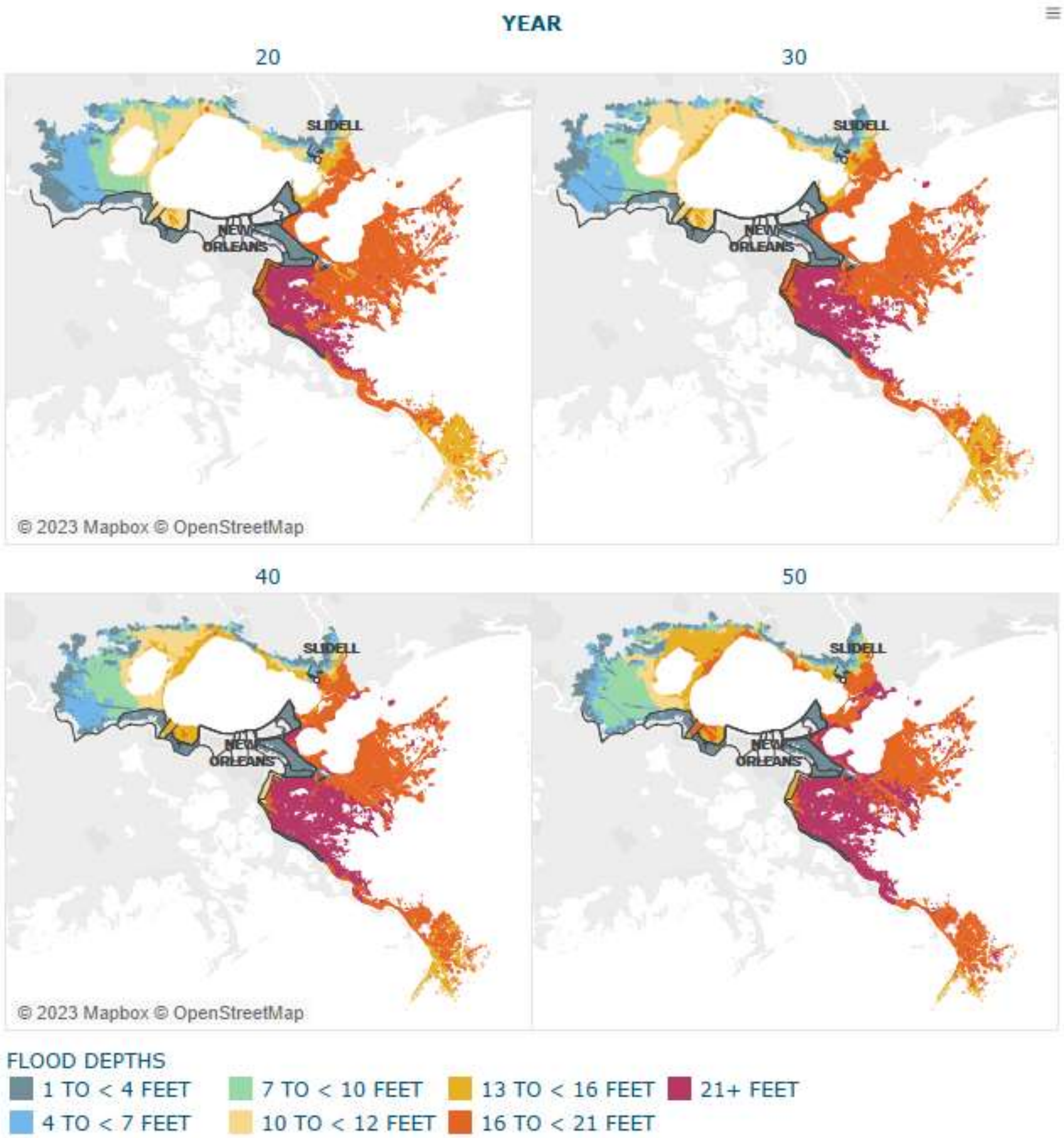

Figure 38. 1% annual chance (1 in 100-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50^{th} percentile.

As with the 10% AEP higher scenario results, most areas of Pontchartrain/Breton see at least 1-2 feet of additional flood depth by Year 30 and 3-4 feet of additional depth by Year 50. Both the levels and magnitude of change in the Slidell vicinity are particularly of note due to the number of people and concentration of assets in the Slidell urban area. Note also that the east bank HSDRRS and WSLP levee systems show selected areas of rainfall flooding, but not overtopping from storm surge and waves, even with the highest SLR assumptions (Year 50, higher scenario). This is due largely to the assumed improvements over time for these federal levees, with either “over-designed” elements (e.g., Lake Borgne surge barrier) or assumed levee lifts intended to offset the effects of ongoing SLR and subsidence. However, overtopping does occur at the 0.2% (1 in-500 year) annual chance event (not shown).

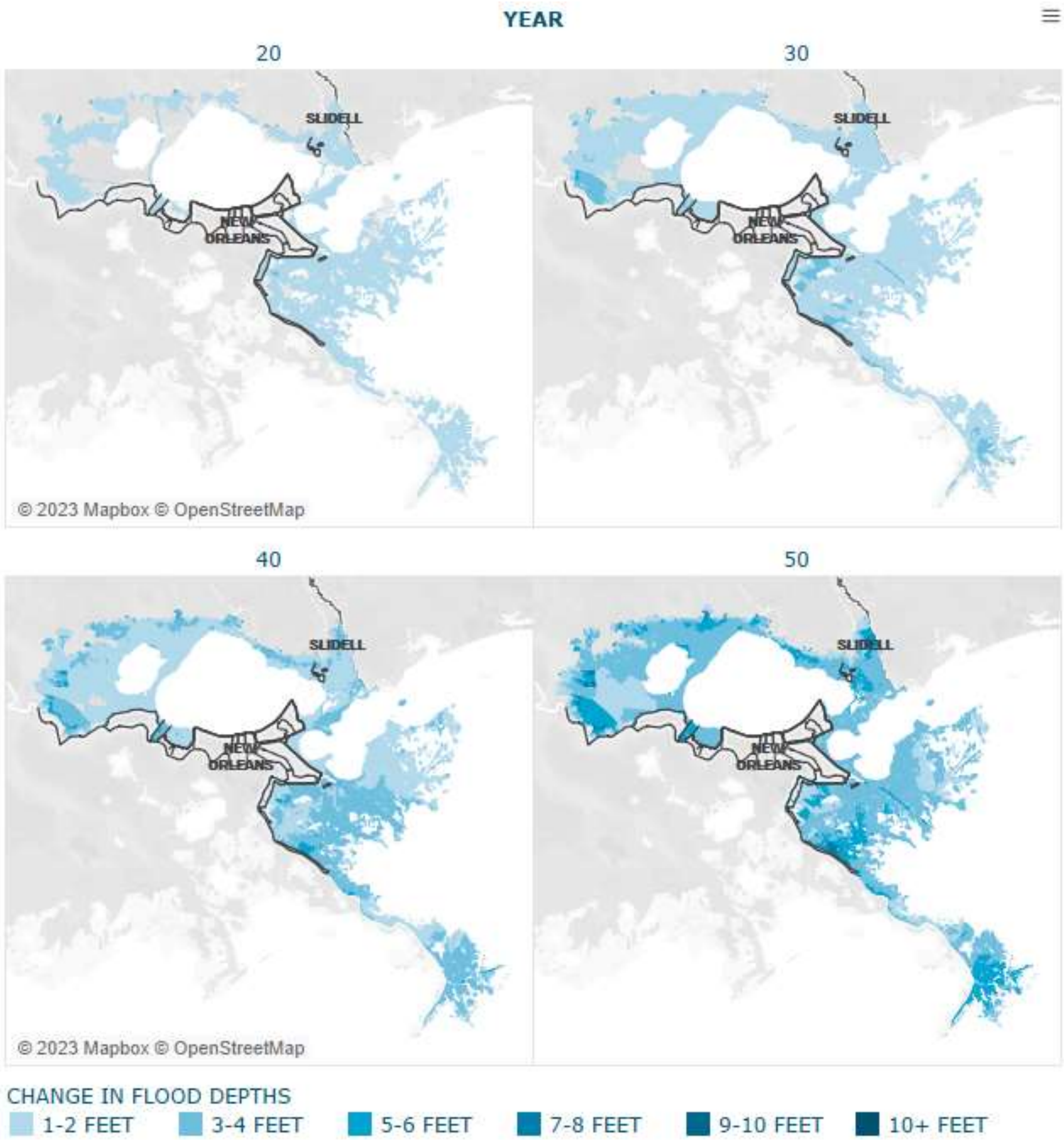

Figure 39. Change in 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

DISCUSSION

The CLARA simulations for the Pontchartrain/Breton region show increases in both the extent and depth of flooding over the period of analysis. These increases are more linear in the lower scenario, but in the higher scenario, the depth trend accelerates over time, particularly in years 40-50. This appears driven primarily by the assumed rates of SLR in each environmental scenario, with the accelerating trend in the higher scenario leading to correspondingly higher and more widespread coastal flood depths. In general, the eastern and more coastward part of the region starts with high projected flood depths, while areas to the north and west have limited flood extents and depths early on but show notable increases in both through the 50-year projections. These changes along the west and north shore of Lake Pontchartrain in turn drive significant increases in flood exposure and damage, discussed in detail in the next section.

The enclosed east bank HSDRRS, including the City of New Orleans and portions of the Greater New Orleans metropolitan region, does not show notable changes in projected 10% or 1% AEP flood depths in either scenario. As noted previously, this is because the 2023 Coastal Master Plan assumes that planned improvements (lifts) to the levee system will be implemented as planned by USACE to keep pace with RSLR. For these regions, CLARA estimates suggest that the planned improvements are sufficient to prevent flooding from overtopping and associated levee failure up to the 1% annual chance (1 in-100-year) flood event in both environmental scenarios through the 50-year analysis period. This is an important assumption for the 2023 risk analysis overall, and particularly for east bank HSDRRS and Greater New Orleans.

2.5 FLOOD DAMAGE PROJECTIONS

Flood consequences for Pontchartrain/Breton are presented for each FWOA scenario in turn below.

LOWER SCENARIO

The proportion of single-family residences in each community with moderate exposure to flooding in the lower scenario is shown in Figure 40 for years 20-50. The proportion of residences exposed in rural areas outside of New Orleans HSDRRS or other levee systems begins at a high level, but for a comparatively small number of homes. Areas with higher density but exterior to HSDRRS and other levee systems, such as portions of Slidell, Mandeville, Lacombe, and other communities on the north shore of Lake Pontchartrain, show approximately 20-40% of homes with moderate exposure in Year 20, although some portions of south Slidell close to the shoreline (e.g., Eden Isle) show much higher exposure rates (80% in Year 20, increasing to 89% by 2050 in the lower scenario). These areas generally show modest increases in the percent of exposed homes over time, on the order of 3-9%. Gonzales/Prairieville, which is on the outer boundary of the flooded region in Year 20, shows a similar increase over time (from 14% to 19% of homes with moderate exposure from Year 20 to Year 50). The proportion is relatively constant over time for communities within HSDRRS, finally, because flooding is largely driven by rainfall as previously observed.

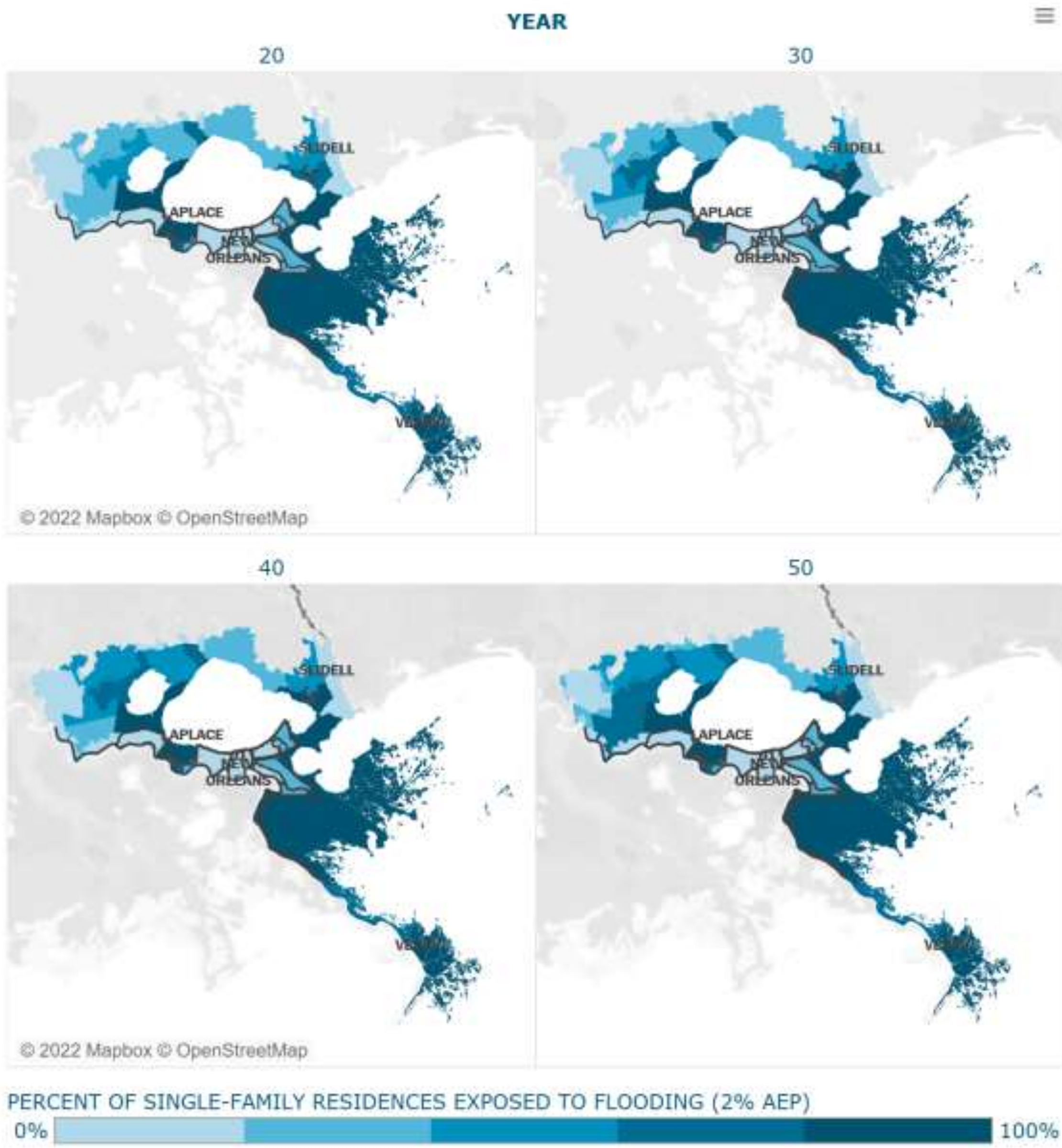

Figure 40. Residential structures exposed to 2% annual chance (1 in 50-year) flood depths above first floor elevation in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Figure 41 summarizes structure exposure results across the entire Pontchartrain/Breton region by decade. The structure inventory includes approximately 327,000 single-family residences in this region, of which 56,000 (17% of homes) are at or above the moderate exposure threshold at the 2% AEP in Year 0, and 20,000 (6%) are at or above the severe exposure threshold. These numbers grow to 65,000 (20%) and 29,000 (9%), respectively, by Year 50 in the lower scenario.

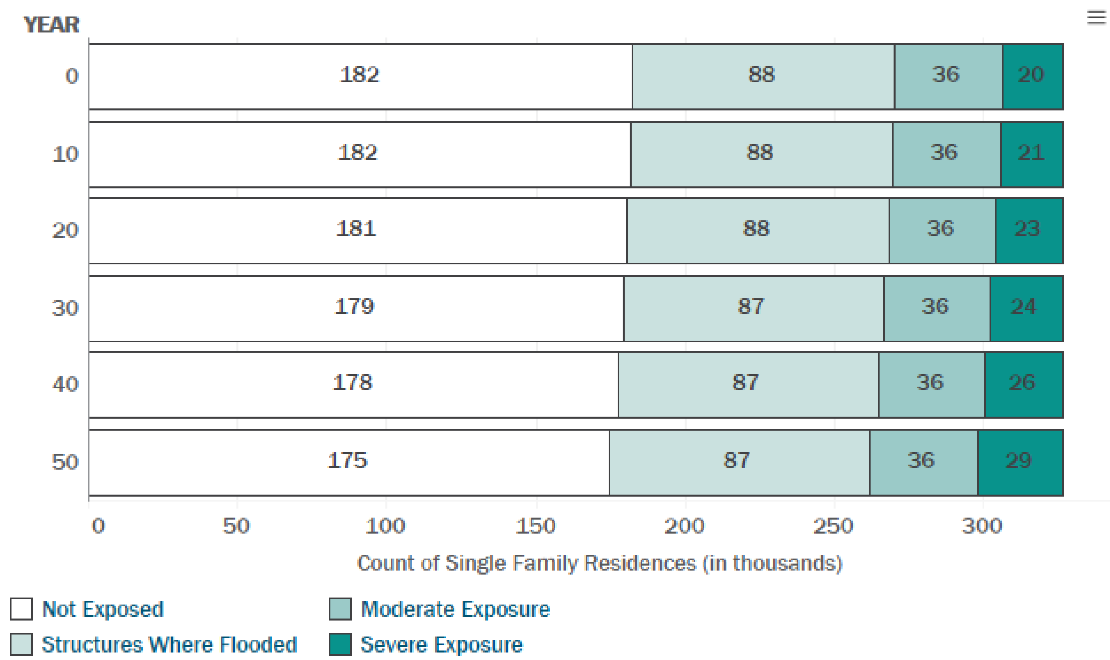

Figure 41. Residential structures exposed to 2% annual chance (1 in 50-year) flooding by exposure category in lower scenario — IPET fragility, 50% pumping scenario, 50th percentile. Note: existing residences only, not accounting for population change.

Turning next to damage, Figure 42 summarizes damage by EADD (left pane) or EASD (right pane; single-family residences only) for the entire Pontchartrain/Breton region. Colors in the left pane distinguish between direct structure damage (purple shading) and additional costs such as relocation expenses (gray shading).

Both panes show a similar pattern in different units: a more gradual increase in damage from Year 0 through Year 20 followed by a more rapid increase through the remaining decades in the simulation. Overall, EADD in the Pontchartrain/Breton region increases from $2.3 billion in Year 0 to $4.8 billion in Year 50 in the lower scenario, more than doubling (109%) over the period of analysis. Approximately one-third of the estimated EADD by decade is direct structure damage. EASD increases from 1,942 to 4,356 over the period of analysis in the lower scenario (right pane), a change of 124%.

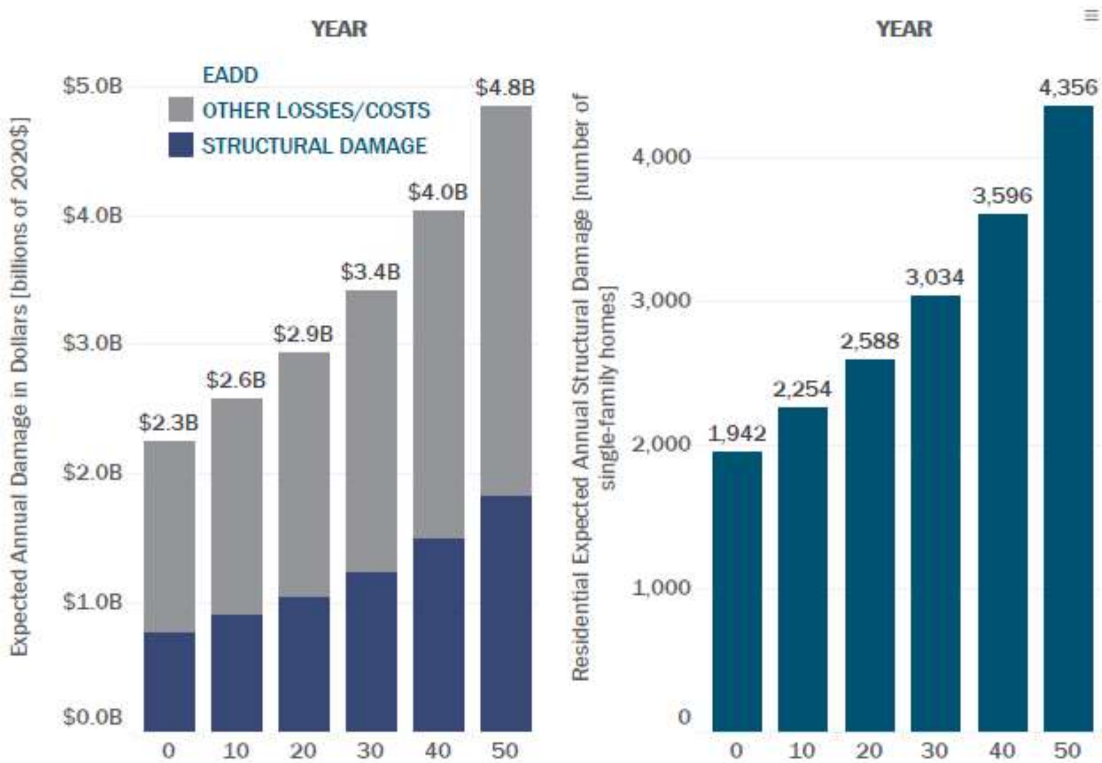

Figure 42. EADD (left) and residential EASD (right) in the Pontchartrain/Breton region in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

EADD by community is mapped in Figure 43 for Year 0 (left pane) and Year 50 (right pane). The colors are presented on an exponential scale to better highlight the range of EADD by community. Figure 44 highlights the change in EADD between these two periods in the lower scenario. Beginning in Year 0, EADD is distributed across a number of Pontchartrain/Breton communities, with areas on the Northshore including Slidell and Mandeville/Covington contributing a comparatively greater share. CLARA also projects EADD within HSDRRS, especially in Destrehan/New Sarpy/Norco (approximately $300 million in Year 0). As noted previously, this is driven by rainfall flooding — in Destrehan/New Sarpy/Norco, for example, Year 0 EADD drops to $50 million if pumps work at 100% of rated capacity (100% pumping scenario; not shown).

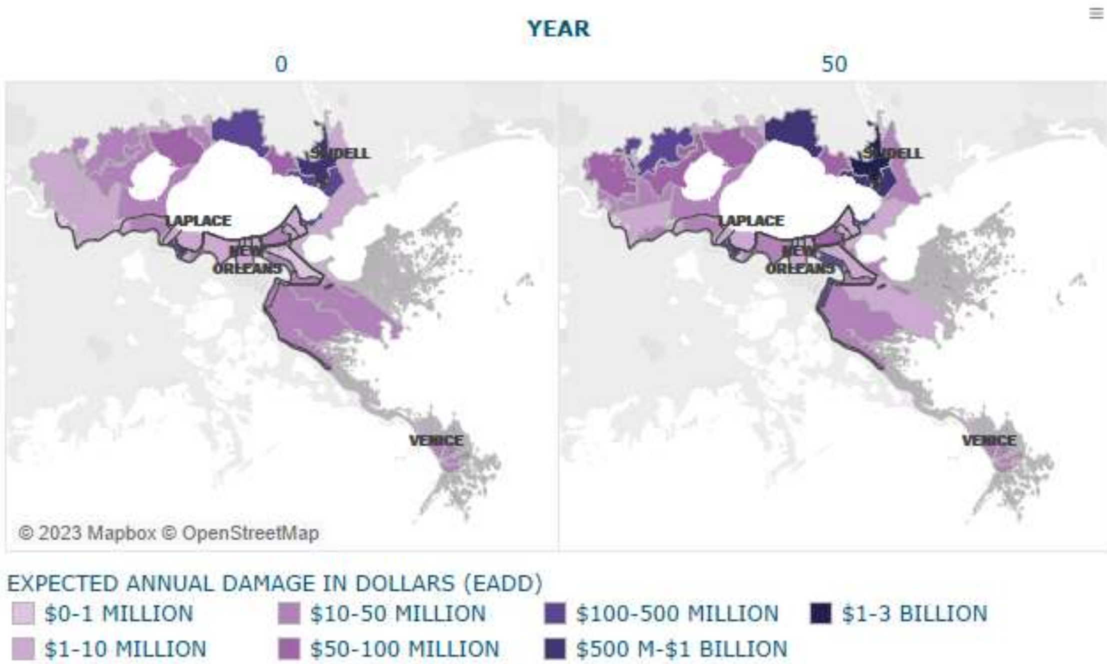

Figure 43. EADD by community in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

By Year 50, EADD in the lower scenario increases in more densely populated areas but declines in selected rural communities (Figure 44). Increases are projected in communities across the north and west shore of Lake Pontchartrain and extend to communities initially on the margin of areas exposed to coastal flooding near Baton Rouge (e.g., Gonzales/Prairieville; portions of Livingston Parish). Damage increases are driven both by projected population increases in more densely populated areas (Hauer et al., 2022) as well as changes driven by the lower environmental scenario. Specifically, lower scenario SLR and higher storm intensity lead to increase in the extent and depth of flooding across the Pontchartrain/Breton region. By contrast, some areas experiencing additional environmental risk (e.g., portions of Plaquemines and St. John the Baptist parishes outside of levee systems) nevertheless show declining EADD by Year 50 due to the projected reduction in population, with values of assets at risk declining faster than flood exposure increases.

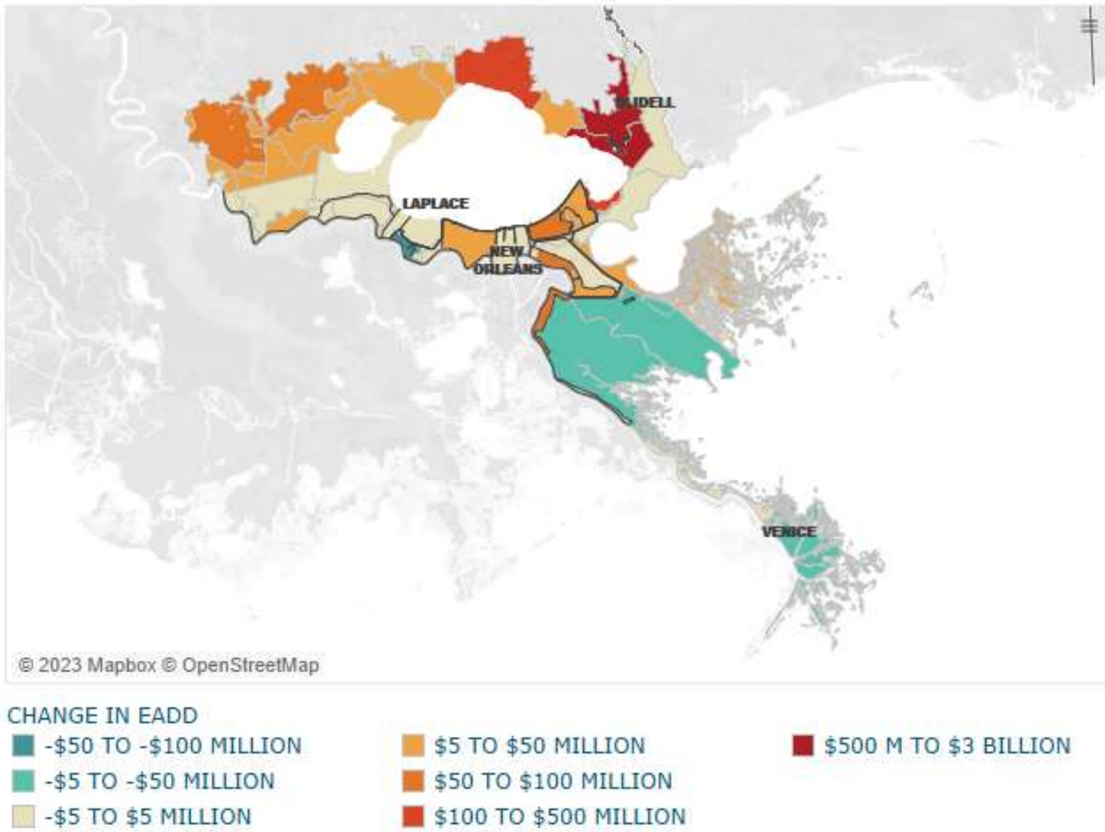

Figure 44. Change in expected annual damage by community in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile, Year 50 – Year 0.

EADD change over time is highlighted for selected communities in Figure 45 below. The top pane shows selected communities in St. Tammany Parish, with other Pontchartrain/Breton parishes in the bottom pane (note different scales between each figure). The top pane highlights the significant EADD increase projected for Slidell/Eden Isle/Pearl River in the lower scenario (from $800 million in Year 0 to $2.3 billion in Year 50). Mandeville/Covington shows a more modest trend by comparison, while EADD in Lacombe is largely unchanged. In the bottom pane, Destrehan/New Sarpy/Norco damage is projected to decline over time (due to declining population and relatively constant rainfall flood risk). Other highlighted communities either show flat or modestly increasing EADD in the lower scenario, driven by the same trends noted above.

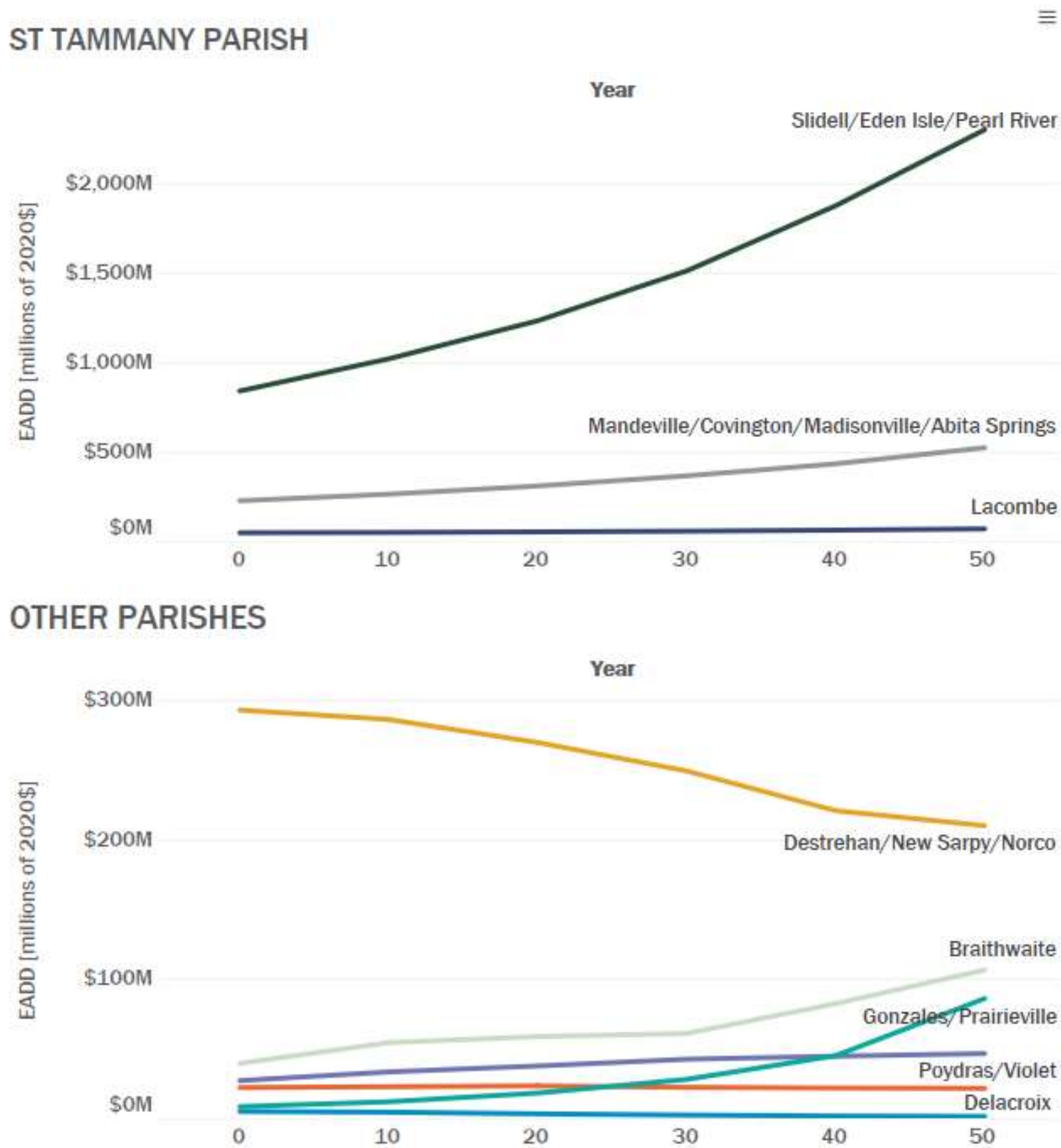

Figure 45. EADD in selected Pontchartrain/Breton communities over the 50-year simulation period in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

HIGHER SCENARIO

The proportion of single-family residences in each community with moderate exposure to flooding in the higher scenario is shown in Figure 46 below for years 20-50. The projected patterns of exposure are similar to the lower scenario (see Figure 40) but with a more rapid rate of change across the decades for selected areas. Notably, exposure grows more rapidly for homes on the west shore of Lake Pontchartrain in the vicinity of Lake Maurepas. Though this area generally has few assets, the neighboring communities of Gonzales/Prairieville, which are on the outer boundary of the flooded region in Year 20, show a more rapid increase over time (from 15% to 32% of homes with moderate exposure from Year 20 to Year 50). Residential flood exposure is consistently high (80-100%) over the simulation for most of east bank Plaquemines Parish, with nearly all communities showing nearly 100% residential exposure except for the levee-enclosed area of Phoenix to Bohemia (23% exposure in Year 20, growing to 28% in Year 50).

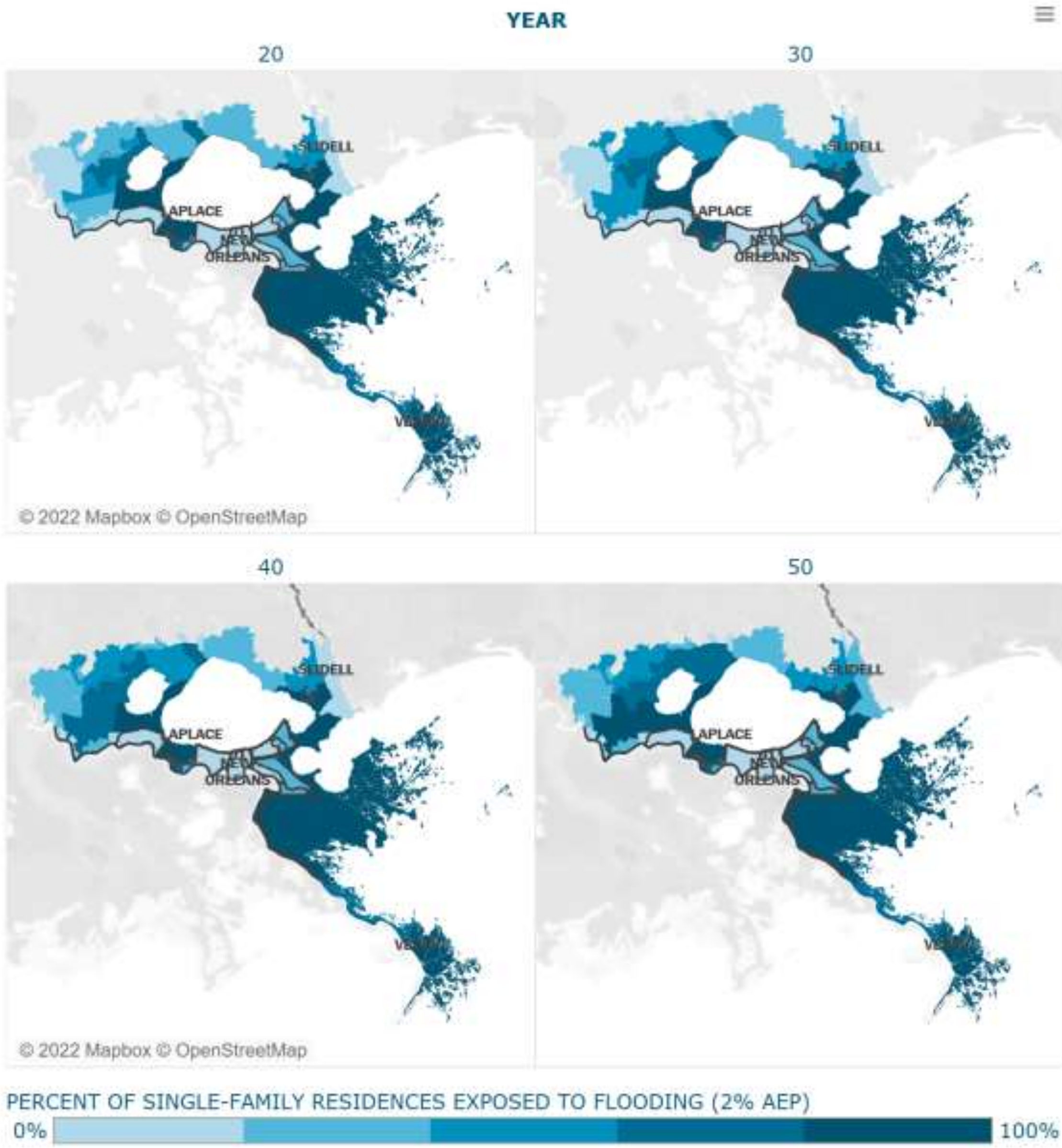

Figure 46. Residential structures exposed to 2% annual chance (1 in 50-year) flood depths above first floor elevation in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Figure 47 summarizes residential structure exposure results across the entire Pontchartrain/Breton region for the higher scenario. This figure highlights the rate of residential exposure growth in the higher scenario, especially from Year 30-50, corresponding with the more rapid acceleration of SLR in the later decades of this scenario. Of the approximately 327,000 single-family residences in this region, 79,000 (24% of homes) are at or above the moderate exposure threshold at the 2% AEP by Year 50, and 41,000 (13%) are at or above the severe exposure threshold. Notably, the number of homes in Pontchartrain/Breton at or above the severe exposure threshold more than doubles over the 50-year simulation period in the higher scenario.

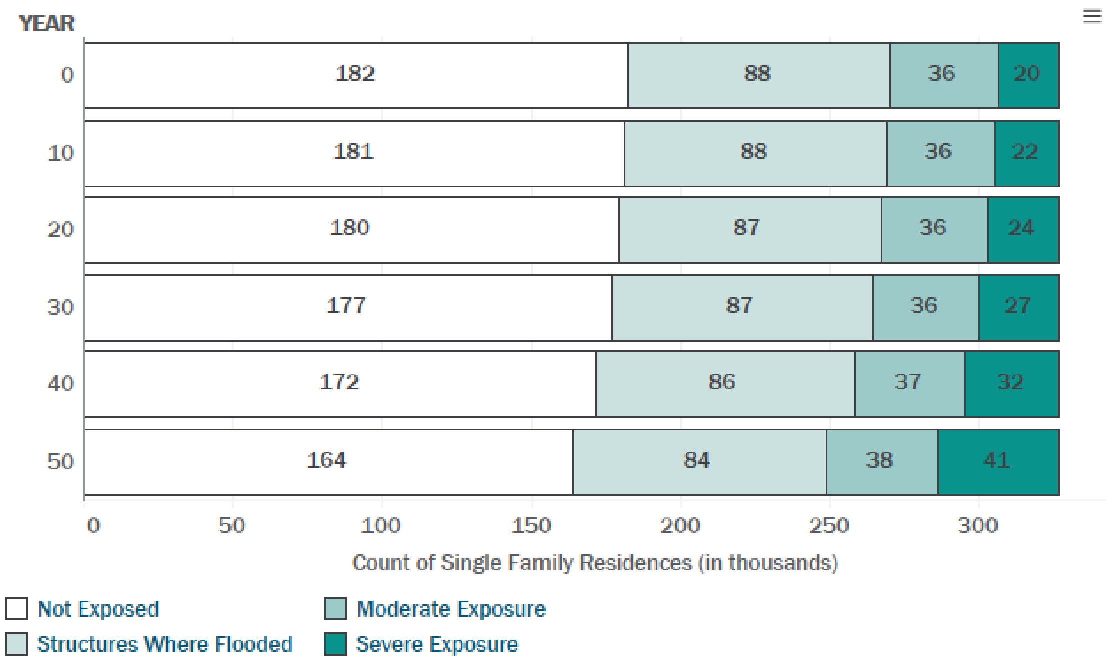

Figure 47. Residential structures exposed to 2% annual chance (1 in 50-year) flooding by exposure category in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Flood damage in Pontchartrain, estimated in either EADD or EASD terms, also increases more rapidly over the 50-year simulation period in the higher scenario (Figure 48 below). Starting from a base of $2.3 billion, EADD grows at a similar pace as in the lower scenario through Year 30 ($3.9 billion in the higher scenario; $3.4 billion in the lower scenario). However, damage increases at a much higher rate in the final two decades, reaching $5.1 billion by year 40 and $7.6 billion by Year 50. This represents a 230% EADD increase in Pontchartrain/Breton over the 50-year simulation period. Region wide EASD shows a similar pattern of acceleration, doubling from 3,458 in Year 30 to 6,823 by Year 50.

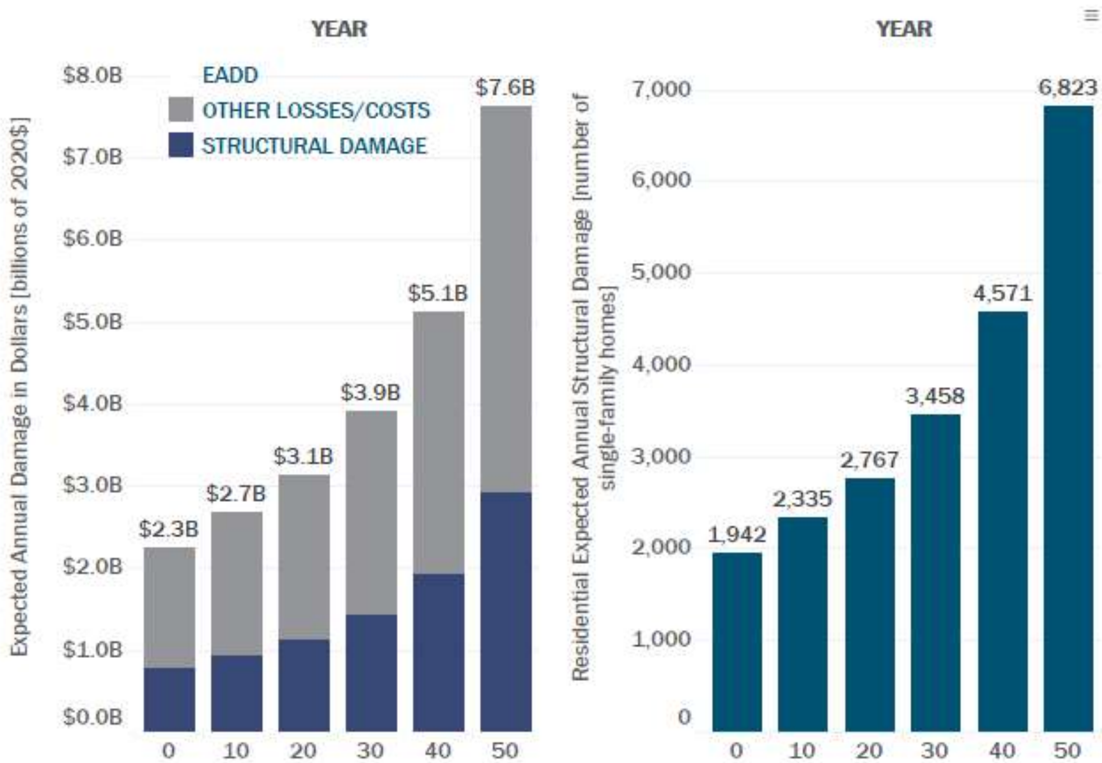

Figure 48. EADD (left) and residential EASD (right) in the Pontchartrain/Breton region in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The map of EADD by community in Year 0 and Year 50 for the higher scenario shows a similar pattern to the lower scenario, with several exceptions (Figure 49 and Figure 50 below). Some areas on the north and west boundary of the coastal zone, such as Ponchatoula/Springfield and other portions of Livingston and Tangipahoa parishes, show accelerated rates of damage increase and a wider resulting gap between the scenario results. For example, Year 50 Ponchatoula/Springfield EADD is estimated at $10 million in the lower scenario, but in the higher scenario, the estimate increases to $31 million. Nearby Gonzales/Prairieville Year 50 EADD also jumps dramatically when comparing scenarios ($87 million in the lower scenario; $431 million in the higher scenario; see Figure 51).

Flooding from storm surge and waves also affects east bank HSDRRS communities in the higher scenario by Year 50. Although 1% AEP flood depths in this year and scenario remain rainfall-driven (Figure 38), flooding driven by levee overtopping is noted at the 0.2% AEP and less likely exceedance probabilities for portions of Greater New Orleans. In turn, these low-probability, high-consequence events affect the EADD estimates, leading to increases of more than $100 million, respectively, in east bank Jefferson Parish, Central New Orleans, Eastern New Orleans, and the sub-basin that includes the Lower Ninth Ward and Chalmette, Arabi, and Meraux in St. Bernard Parish.

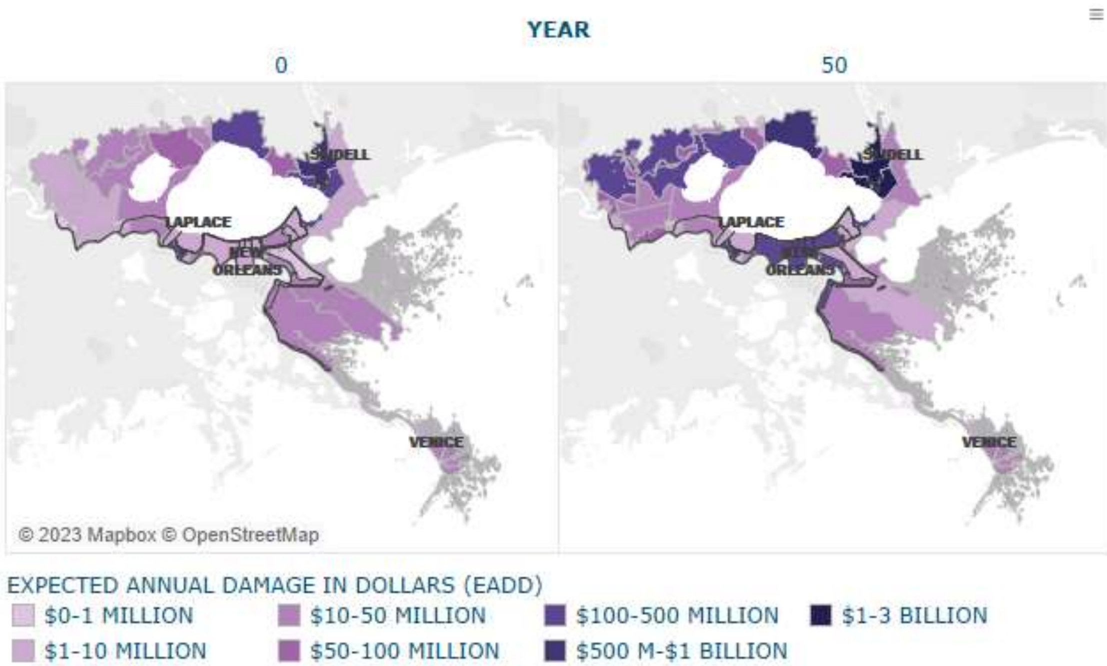

Figure 49. EADD by community in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

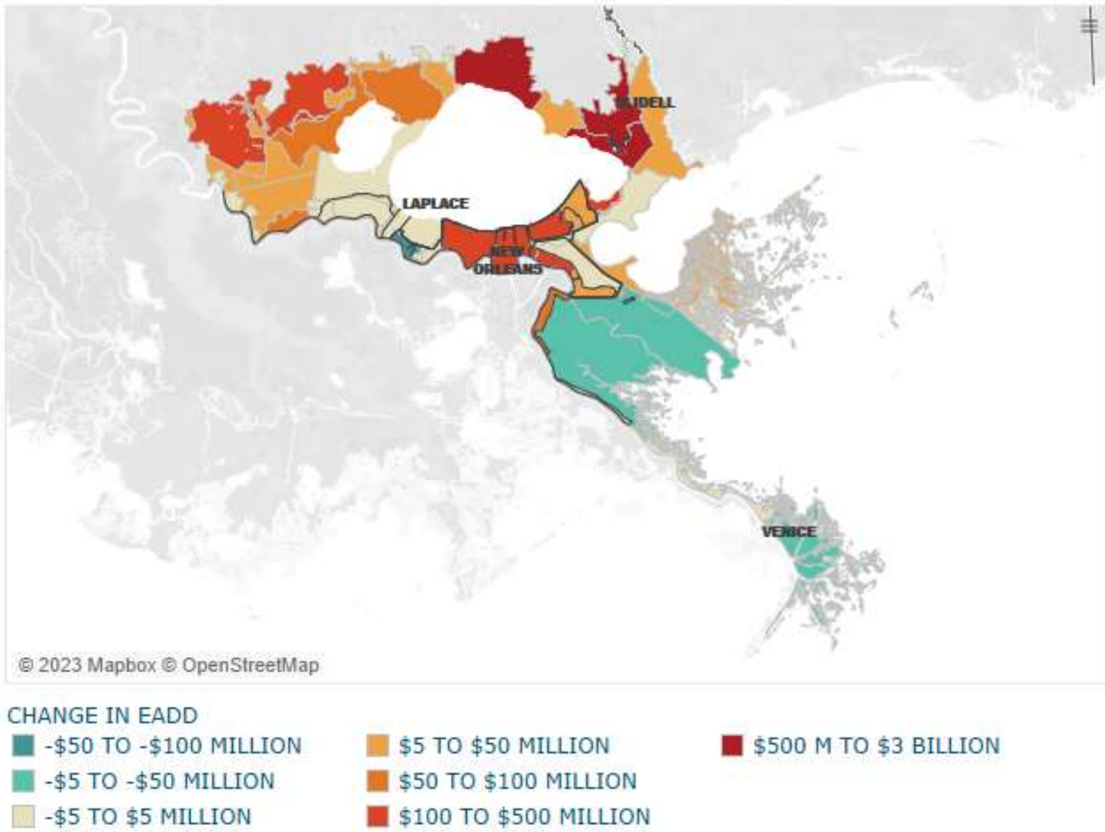

Figure 50. Change in expected annual damage by community in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile, Year 50 — Year 0.

Overall, EADD estimates are significantly higher by community in the higher scenario, but some areas still show net negative EADD change due to population loss (Figure 50). Selected higher density communities account for much of the dramatic acceleration in EADD in the higher scenario (Figure 51), including Slidell/Eden Isle/Pearl River, Mandeville/Covington/Madisonville/Abita Springs, and Gonzales/Prairieville. The rapid acceleration from Year 30 to 50 is especially notable in Gonzales/Prairieville. Other communities selected for this plot show lower or flat rates of EADD growth (e.g., Braithwaite, Poydras/Violet), while Destrehan/New Sarpy/Norco shows declining EADD resulting from projected population loss as in the lower scenario.

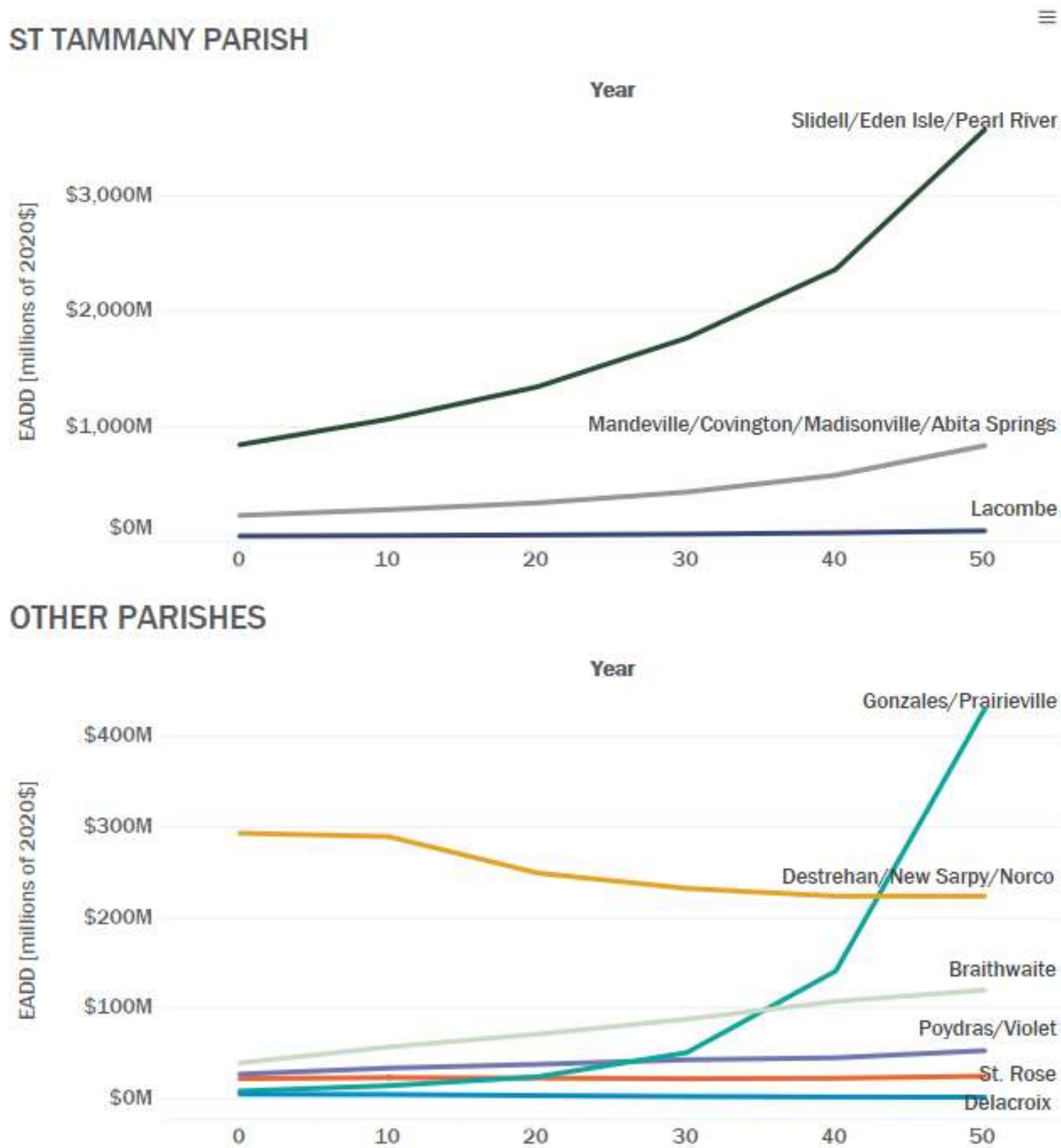

Figure 51. EADD in selected Pontchartrain/Breton communities over the 50-year simulation period in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

DISCUSSION

There are several notable storylines that emerge from the CLARA flood damage estimates for Pontchartrain. First, following the depth results, increases in flood exposure and damage occur largely in communities on the north and west shore of Lake Pontchartrain. For Northshore communities like Slidell, this is driven by increasing flood depths over the 50-year simulation; alternately, for communities to the west such as Gonzales/Prairieville, the change is driven more by the increasing extent of coastal flooding that occurs in both environmental scenarios because of subsidence and SLR. Slidell/Eden Isle/Pearl River appear to be of particular concern in later decades, with EADD estimates exceeding $2 billion in the lower scenario and $3 billion in the higher scenario for this community alone.

Overall, damage increases basin wide are closer to linear in the lower scenario but show an accelerating rate of increase in later decades in the higher scenario. This appears to be closely tied to the accelerating SLR rate assumed in this scenario. Although some areas nearest to the coast are projected to decline in population and see corresponding reductions in projected damage, this is more than offset across the region by more densely populated areas facing significantly greater flood exposure. Finally, the simulations show relatively little change or increase in EADD within east bank HSDRRS due to the assumed improvements to the levee system over time. If these improvements did not occur or were delayed, depth and damage projections within HSDRRS could increase dramatically in either or both scenarios by Year 50.

3.0 BARATARIA

3.1 DESCRIPTION

GEOGRAPHY

The Barataria region is defined on its northern and eastern boundaries by the Mississippi River, running from Donaldsonville at its northernmost point to the western half of the Bird's Foot Delta at the mouth of the river in lower Plaquemines Parish. The western boundary follows Bayou Lafourche from Donaldsonville south, through Thibodaux and Raceland, to Port Fourchon. The bayou runs through the Larose to Golden Meadow Hurricane Protection Project, so part of that polder is included in the Terrebonne region rather than Barataria.

The region is dominated by extensive coastal wetlands bisected by several former distributary channels of Bayou Lafourche and the Mississippi River. The highest land elevation in the Barataria region is located atop the banks of these former distributary channels. The Gulf Intracoastal Waterway (GIWW) bisects the region, dividing it into an upper and lower portion.

The upper portion of the basin consists primarily of coastal forested wetlands, marshes, and associated water bodies. Several fastlands bisect this region. Because the highest land elevations occur on the banks and fastlands of Bayou Lafourche and the Mississippi River and other former distributary channels, developed areas are generally located there. Much of this development centers on the Mississippi River and includes a combination of urban, suburban, and rural/agricultural development, with high density urban development centered on the west bank of the Mississippi River in and around the New Orleans Metropolitan Area (Figure 52).

The lower portion of the region consists primarily of tidally influenced marshes connected to a large bay system. Beyond these bays, a chain of barrier islands including Scofield, Pelican, Shell, Chaland Headland, Grand Pierre, East Grand Terre, West Grand Terre, and Grand Isle, separates the Barataria Basin from the Gulf. Grand Isle is the only barrier island in Louisiana that is human occupied. Beyond Grand Isle, the communities of the lower portion of the region, like those of the upper portion, are located along the linear threads of high ground along Bayou Lafourche and the Mississippi River.

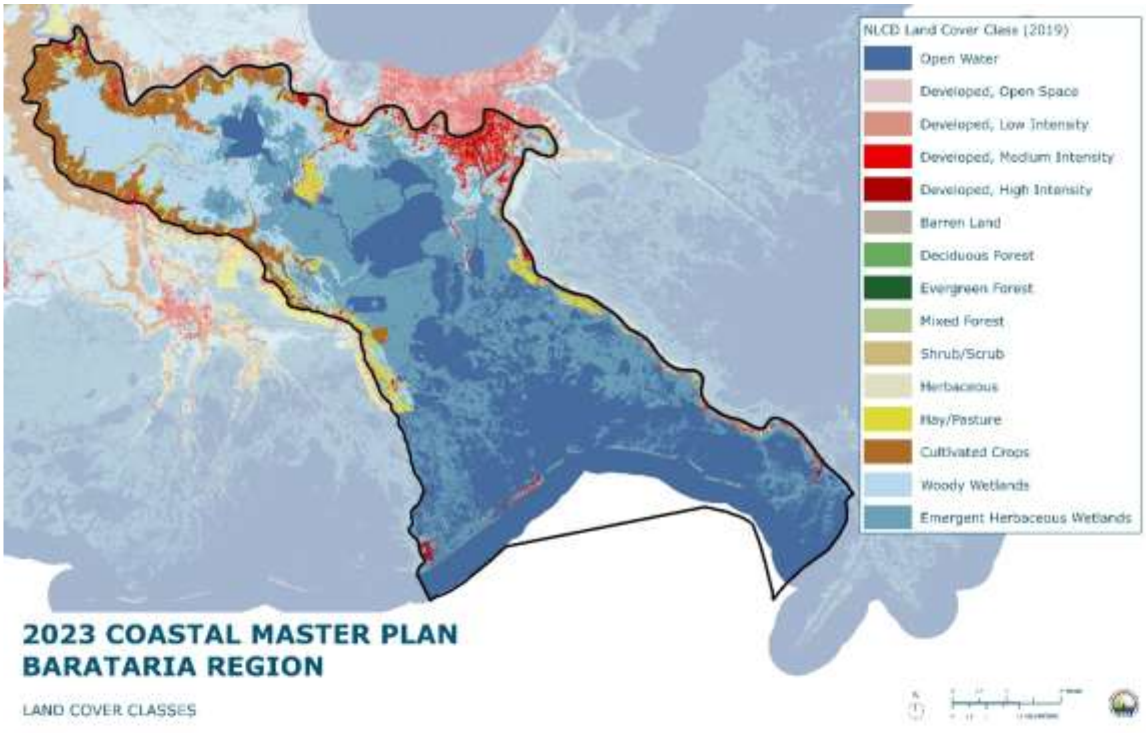

Figure 52. Land cover types in the Barataria region.

STRUCTURAL PROTECTION

The natural elevation of the banks of Bayou Lafourche and the Mississippi River provides a degree of protection from coastal storm and riverine flood events for the communities located along them. However, the proximity of many of these communities to the Gulf make them especially vulnerable to storm surge and other tropical weather hazards, many of which are powerful enough to overtop the natural levees. In addition, Lake Salvador and many of the interior lakes and waterways between Bayou Lafourche and the Mississippi River provide direct avenues for storm surge to push into the upper portion of the Barataria region and threaten communities in the region.

To address the heightened vulnerability of the Barataria region, many of the communities located along the primary waterways rely upon structural protection (Figure 53). A series of federal river levees and floodwalls reinforce the natural levees of the Mississippi River, providing protection from riverine flooding for communities in the Barataria region from the River Parishes to Lower Plaquemines Parish. This includes the heavily urbanized Westbank communities within the New Orleans Metropolitan Area, a location that is further protected by HSDRRS, a series of levees, floodwalls, and gates engineered to provide a 100-year level of risk reduction against tropical events and related rainfall and storm surges. HSDRRS was constructed following Hurricane Katrina to protect the densely populated New Orleans

Metropolitan Area, including several Westbank communities in Jefferson Parish such as Algiers, and Belle Chasse as well as smaller communities in St. Charles Parish such as Ama. Downriver of HSDRRS in Plaquemines Parish, the communities of lower Plaquemines Parish are protected by both non-Federal and Federal levees, including New Orleans to Venice, a Federal levee constructed to HSDRRS standards to provide storm risk reduction to Plaquemines Parish communities on both the east bank and west bank of the Mississippi River.

The Barataria region also contains several densely populated communities located along Bayou Lafourche, many of which are located south of the GIWW. These communities are protected by the Larose to Golden Meadow Hurricane Protection Project, a ring levee approximately 48 miles in length enclosing the areas along the east and west banks of Bayou Lafourche from the GIWW at Larose to just south of Golden Meadow. Designed to provide a 100-year level of hurricane protection, the project also provides for the construction of navigable floodgates on Bayou Lafourche at the upper and lower limits of the project area. Finally, the residents of Grand Isle are protected by a 13-foot-high levee constructed by USACE in 2010. Commonly known as the burrito levee, this 7.7-mile-long feature is designed to protect the 1,700 structures on the island from a surge event with a 2% chance of occurring in any year.

Figure 53. Structural protection in the Barataria region.

POPULATION

The Barataria region is divided into the Upper Barataria Basin and the Lower Barataria Basin by the GIWW, a federal navigation channel with a controlling depth of 12 feet designed primarily for barge transportation. The upper and lower portions of the Barataria Basin each have their own unique physiography and related human and cultural geography. The upper basin is bifurcated into a primarily rural and agricultural western portion and a highly urbanized and industrialized eastern portion. The eastern portion of the Upper Barataria Basin is dominated by the highly urbanized landscapes that comprise much of the New Orleans Metropolitan Area located on the west bank of the Mississippi River. The Lower Barataria Basin contains two fastland population centers separated by an expanse of coastal marshland and bays, one in Lafourche Parish along Bayou Lafourche and one in Plaquemines Parish along the Mississippi River.

UPPER BARATARIA BASIN: THE RIVER PARISHES AND UPPER BAYOU LAFOURCHE

The Upper Barataria Basin includes portions of several parishes, including Assumption, Ascension, St. James, Lafourche, and St. John the Baptist. The landscape consists primarily of two populated fastland areas atop the levees and banks of Bayou Lafourche and the Mississippi River separated by the Des Allemands sub-basin, a broad expanse of forested wetlands containing Lac Des Allemands and the Lac Des Allemands Swamp. Most of the development in the northern portion of the region is found in the fastlands and incudes a combination of suburban and rural/agricultural development (Figure 54). Sugarcane is the dominant agricultural crop grown the region, with smaller amounts of corn, potatoes, rice, cotton, and fruit crops also present. Cattle grazing and pastureland are also important economic activities that occur in the fastland areas of the upper basin.

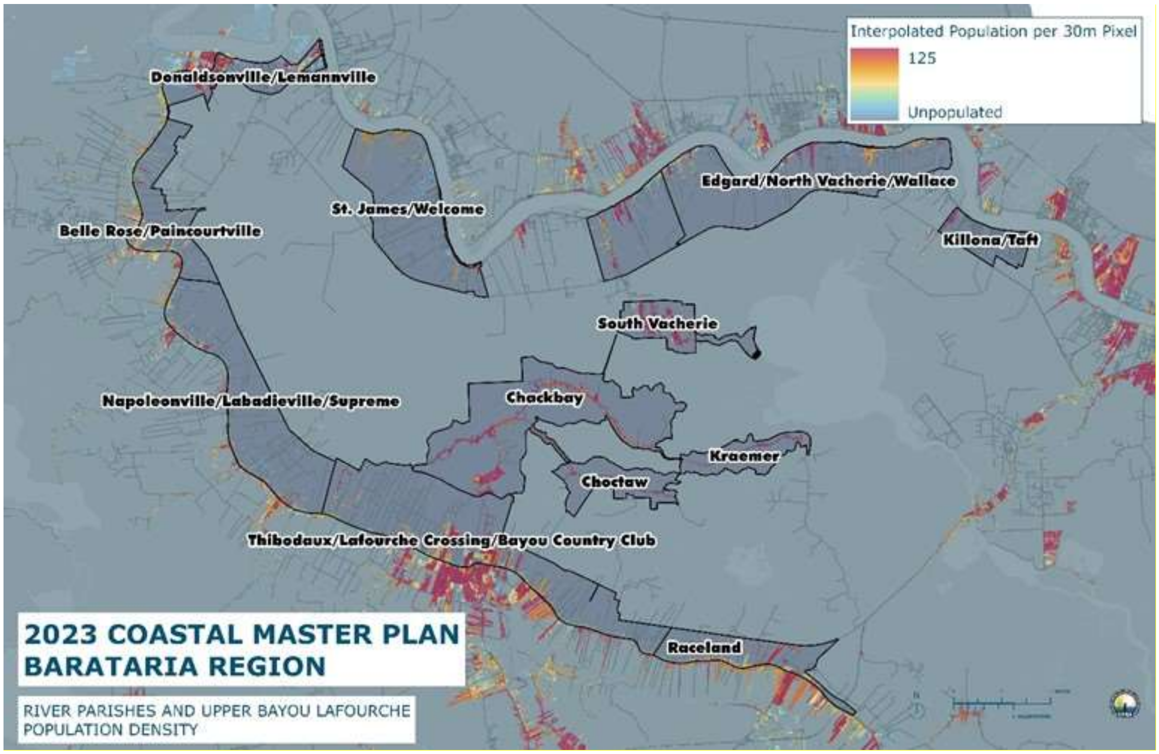

Figure 54. Population density of communities comprising the Upper Barataria Basin outside the New Orleans Metropolitan Area.

The population of the Upper Barataria Basin shows very different demographic patterns in the two primary fastlands (Table 5). Communities located along the Mississippi River have proportions of Black residents significantly higher than the statewide average of 33%. This is also true for communities located along upper Bayou Lafourche near its junction with the Mississippi River, including Belle Rose/Paincourtville, Donaldsonville/Lemannville, and Napoleonville/Labadieville/Supreme. South of these areas in Lafourche Parish, communities such as Thibodaux and Raceland have proportions of Black residents lower than the statewide average, a pattern that continues with increasing proximity to the Gulf. Similarly, the fisheries-dependent communities located around Lac Des Allemands and the Lac Des Allemands Swamp, including Chackbay, Choctaw, Kraemer, and South Vacherie, tend to be predominantly white, with lower-than-average minority populations.

Table 5. Demographics of Upper Barataria Basin communities outside the New Orleans Metropolitan Area

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
BELLE ROSE/ PAINCOURTVILLE	5,029	2,017	2,822	8	8	118	1,215
		40.1%	**56.1%**	**0.2%**	**0.2%**	**2.3%**	**12.5%**
CHACKBAY	5,727	5,102	248	36	20	181	885
		89.1%	**4.3%**	**0.6%**	**0.3%**	**3.2%**	**14.8%**
CHOCTAW	775	740	7	1	0	11	131
		95.5%	**0.9%**	**0.1%**	**0.0%**	**1.4%**	**14.8%**
DONALDSONVILLE/ LEMANNVILLE	8,682	2,049	6,269	4	14	240	4,092
		23.6%	**72.2%**	**0.0%**	**0.2%**	**2.8%**	**39.6%**
EDGARD/NORTH VACHERIE/WALLACE	4,920	710	4,019	3	1	58	1,485
		14.4%	**81.7%**	**0.1%**	**0.0%**	**1.2%**	**17.4%**
KILLONA/TAFT	728	8	712	0	1	1	72
		1.1%	**97.8%**	**0.0%**	**0.1%**	**0.1%**	**18.2%**
KRAEMER	877	801	5	2	3	45	299
		91.3%	**0.6%**	**0.2%**	**0.3%**	**5.1%**	**26.0%**
NAPOLEONVILLE/ LABADIEVILLE/ SUPREME	6,982	3,805	2,773	34	18	301	1,807
		54.5%	**39.7%**	**0.5%**	**0.3%**	**4.3%**	**21.8%**
RACELAND	10,675	7,068	2,774	134	45	430	2,138
		66.2%	**26.0%**	**1.3%**	**0.4%**	**4.0%**	**19.3%**
SOUTH VACHERIE	3,696	2,430	1,102	8	1	71	318
		65.7%	**29.8%**	**0.2%**	**0.0%**	**1.9%**	**8.6%**
ST. JAMES/ WELCOME	1,448	106	1,290	2	2	31	1,220
		7.3%	**89.1%**	**0.1%**	**0.1%**	**2.1%**	**31.5%**
THIBODAUX/ LAFOURCHE CROSSING/ BAYOU COUNTRY CLUB	35,607	22,811	10,026	305	274	1,514	6,017
		64.1%	**28.2%**	**0.9%**	**0.8%**	**4.3%**	**15.9%**

MISSISSIPPI RIVER WEST BANK

The Westbank is the portion of the New Orleans–Metairie–Kenner metropolitan statistical area located on the west bank of the Mississippi River in Jefferson Parish. There are two incorporated communities in the Westbank: Gretna (the parish seat) and Westwego (Figure 55). Another incorporated community, Jean Lafitte, is also on the west bank of the river but is located on Bayou Barataria, a tributary of Barataria Bay. Several unincorporated communities are also located in the

Westbank, including Harvey, a densely populated industrialized community, Avondale, Barataria, Lafitte, Marrero, and Waggaman. Barataria and Lafitte, like Jean Lafitte, are located on Bayou Barataria.

Downriver from the Westbank communities of Jefferson Parish is Algiers, the second oldest neighborhood in the city of New Orleans and the only one located on the west bank of the Mississippi River. Beyond this is Belle Chasse, the largest community in Plaquemines Parish and home to Naval Air Station Joint Reserve Base New Orleans.

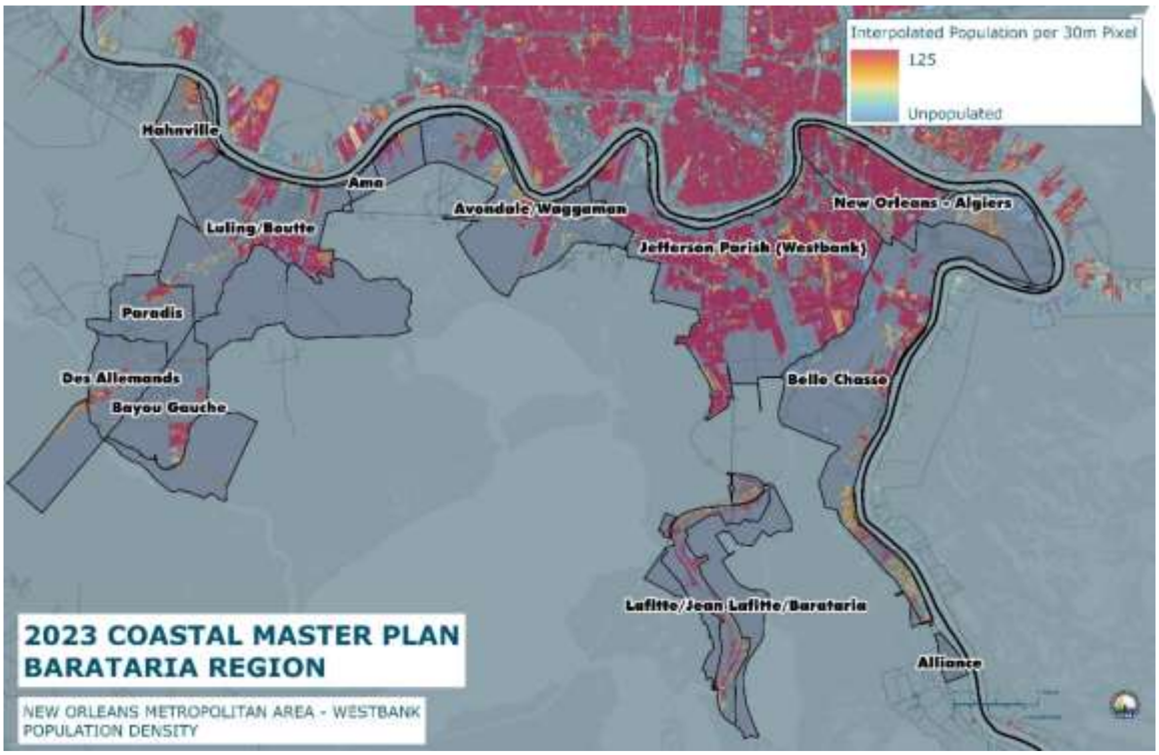

Figure 55. Population density of Westbank communities in the New Orleans Metropolitan Area.

Many similar demographic patterns are seen in the distribution of minority residents in the Westbank as were seen in the western half of the Upper Barataria Basin (Table 6). From Avondale to the industrialized communities of Jefferson Parish's Westbank to the New Orleans neighborhood of Algiers, the proportion of Black residents range from 42 to 66% of the total population, well above the statewide average of 33%. These same locations have higher proportions of Asian residents, again above the statewide average of 1.9%, as does the Plaquemines Parish community of Belle Chasse. As each of these communities are part of the New Orleans Metropolitan Area, the total population in each is also far higher than those of the more agricultural upriver communities.

Beyond these highly and densely populated core areas, the percentage of minority residents tends to decline, particularly in those locations not on the Mississippi River, including Lafitte/Jean Lafitte/Barataria and the fishing communities located on Lac Des Allemands: Bayou Gauche, Des Allemands, and Paradis. It is notable that each of these communities also have higher proportions of Indigenous residents than the statewide average of 0.8%.

Table 6. Demographics of Westbank communities in the New Orleans Metropolitan Area

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
ALLIANCE	7	3	0	0	0	0	0
		42.9%	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
AMA	40	15	7	5	0	9	6
		37.5%	**17.5%**	**12.5%**	**0.0%**	**22.5%**	**9.4%**
AVONDALE/ WAGGAMAN	16,088	5,264	8,645	99	656	1,345	5,093
		32.7%	**53.7%**	**0.6%**	**4.1%**	**8.4%**	**21.1%**
BAYOU GAUCHE	3,121	2,940	30	32	4	58	24
		94.2%	**1.0%**	**1.0%**	**0.1%**	**1.9%**	**0.7%**
BELLE CHASSE	16,706	11,922	1,946	140	504	1,861	2,744
		71.4%	**11.6%**	**0.8%**	**3.0%**	**11.1%**	**11.9%**
DES ALLEMANDS	2,179	1,725	296	24	4	72	481
		79.2%	**13.6%**	**1.1%**	**0.2%**	**3.3%**	**22.1%**
HAHNVILLE	3,024	1,476	1,314	19	17	169	754
		48.8%	**43.5%**	**0.6%**	**0.6%**	**5.6%**	**10.8%**
JEFFERSON PARISH (WESTBANK)	171,988	60,941	73,336	1,046	9,373	25,799	32,162
		35.4%	**42.6%**	**0.6%**	**5.4%**	**15.0%**	**18.4%**
LAFITTE/ JEAN LAFITTE/ BARATARIA	6,654	5,500	136	116	83	498	1,782
		82.7%	**2.0%**	**1.7%**	**1.2%**	**7.5%**	**16.6%**
LULING/BOUTTE	18,352	12,344	4,051	79	204	1,342	4,110
		67.3%	**22.1%**	**0.4%**	**1.1%**	**7.3%**	**13.7%**
NEW ORLEANS – ALGIERS	50,957	10,851	33,837	156	1,290	4,016	12,828
		21.3%	**66.4%**	**0.3%**	**2.5%**	**7.9%**	**20.2%**
PARADIS	1,242	1,004	70	19	12	114	151
		80.8%	**5.6%**	**1.5%**	**1.0%**	**9.2%**	**9.7%**

LOWER PLAQUEMINES PARISH

Several small unincorporated communities are located along the Mississippi River in the lower portion of Plaquemines Parish where the river approaches the Gulf of Mexico, including Port Sulphur, Empire, Buras, Triumph, and Venice (Figure 56). Due to its location at the mouth of the Mississippi River, many residents of the region are employed in commercial shrimping, oyster farming, and seafood processing. Lower Plaquemines Parish also supports a significant tourism industry centered primarily on recreational fishing. The parish is also an important service and transportation hub for the offshore oil and gas industry. The region supports a full spectrum of oil and gas activities: production, storage, transportation, and processing, including natural gas processing.

Figure 56. Population density of communities located in lower Plaquemines Parish.

Unlike many of the other communities in the region, the communities of lower Plaquemines Parish tend to have black and white populations lower than the statewide average (Table 7). In contrast other areas within the Barataria Region, each of the communities in the lower portion of Plaquemines Parish is home to significant numbers of Indigenous and Asian residents. A large number of Vietnamese and Cambodian shrimpers reside in the parish. This is reflected in the demographic profile of the communities in the region, each of which has a higher proportion of Asian residents than the statewide average of 1.9%. Similarly, the communities of lower Plaquemines Parish each have percentages of Indigenous residents at or above the statewide average of 0.8% (Table 8). Lower Plaquemines Parish is home to the Grand Bayou Indian Village, a subsistence-based Indigenous community of Atakapa-Ishak/Chawasha that is only accessible by boat.

Table 7. Demographics of communities located in lower Plaquemines Parish

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
BOOTHVILLE	786	421	162	16	37	58	400
		53.6%	**20.6%**	**2.0%**	**4.7%**	**7.4%**	**29.07%**
BURAS	1,259	541	148	17	379	67	864
		43.0%	**11.8%**	**1.4%**	**30.1%**	**5.3%**	**30.38%**
EMPIRE	1,036	532	261	14	71	115	746
		51.4%	**25.2%**	**1.4%**	**6.9%**	**11.1%**	**33.63%**
PORT SULPHUR	1,891	403	1,163	87	58	61	1,344
		21.3%	**61.5%**	**4.6%**	**3.1%**	**3.2%**	**29.84%**
TRIUMPH	357	211	66	3	41	14	162
		59.1%	**18.5%**	**0.8%**	**11.5%**	**3.9%**	**30.22%**
VENICE	237	163	19	8	18	10	92
		68.8%	**8.0%**	**3.4%**	**7.6%**	**4.2%**	**18.18%**

LOWER LAFOURCHE PARISH

There are two incorporated towns located in Lower Lafourche Parish: Lockport and Golden Meadow. Other communities in the area include the unincorporated towns of Larose, Cut Off, and Galliano (Figure 57). The economy of Lower Lafourche Parish consists primarily of sugarcane production and various coastal industries, including fishing, oil and gas production, and boat construction and repair. Port Fourchon, a deep-draft port at the mouth of Bayou Lafourche on the Gulf, is a major onshore staging area for Outer Continental Shelf (OCS) oil and gas activities in the Central and Western Gulf and the land fall for the Louisiana Offshore Oil Port (LOOP). Over 250 companies utilize Port Fourchon as a base of operations, including over 95% of the Gulf's deepwater energy production. While production occurs offshore, land-based infrastructure is a necessary part of producing and refining these products. The Port itself comprises 1,200 developed acres, a 300 foot wide dredged channel, and numerous docking slips. Approximately 15,000 people are flown to offshore locations from Port Fourchon every month. While many of these workers reside out of the region, many oil and gas support workers reside in Lower Lafourche Parish.

The region also supports a tourism industry, much of which is centered on recreational fishing. Grand Isle is located just to the east of Port Fourchon and is a focal point of regional tourism. Although it is located in neighboring Jefferson Parish, the only road to the island runs through Lafourche Parish.

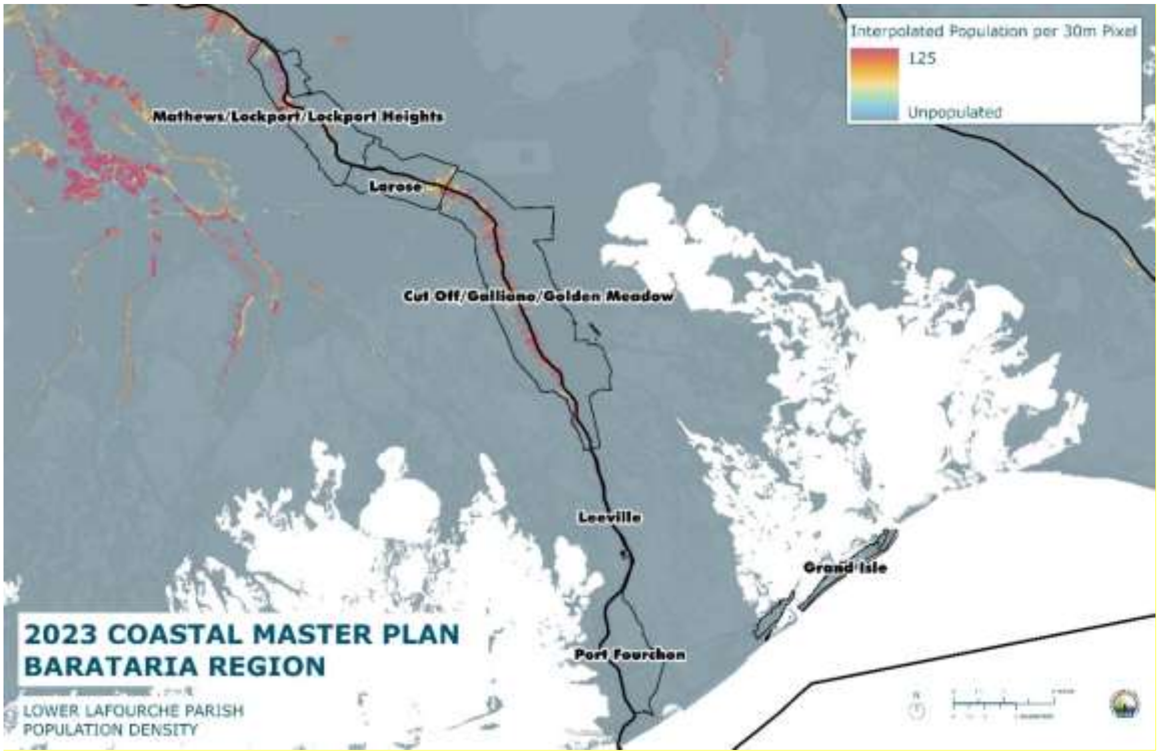

Figure 57. Population density of communities located in and around Lower Lafourche Parish.

Bayou Lafourche, from its junction with the Mississippi River in Donaldsonville to its junction with the Gulf at Port Fourchon, transitions from largely agricultural development to coastal industries such as commercial fishing and boat building and repairing as it moves southward. This economic transition occurs alongside a demographic transition. Unlike many of the communities of the northern basin, the communities of Lower Lafourche Parish tend to have white populations higher than the statewide average.

The communities of Lower Lafourche Parish within the Larose to Golden Meadow Hurricane Protection Project also have significantly high proportions of Indigenous residents relative to the statewide average of 0.8% (Table 8). Lafourche Parish, along with neighboring Terrebonne Parish, is home to the majority of the state's Indigenous residents, who have historically resided along the region's bayou and in the marshes. This includes the United Houma Nation, the largest state-recognized tribe in Louisiana, many of whom reside in Lafourche Parish along Bayou Lafourche. Houma tribe members as well as the other Indigenous tribal bands of the region, including the Bayou Lafourche Biloxi

Chitimacha, the Pointe-au-Chien Indian Tribe, the Isle de Jean Charles Biloxi-Chitimacha-Choctaw, and the Grand Caillou/Dulac Biloxi-Chitimacha-Choctaw, are not federally recognized and live in small coastal communities throughout the Barataria region and well as the neighboring Terrebonne region.

Table 8. Demographics of communities located in and around Lower Lafourche Parish

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
CUT OFF / GALLIANO / GOLDEN MEADOW	19,756	15,506	508	1,040	324	1,935	0
		78.5%	**2.6%**	**5.3%**	**1.6%**	**9.8%**	**0.0%**
GRAND ISLE	1,004	938	4	17	6	30	6
		93.4%	**0.4%**	**1.7%**	**0.6%**	**3.0%**	**9.4%**
LAROSE	3,056	2,626	31	125	21	197	5,093
		85.9%	**1.0%**	**4.1%**	**0.7%**	**6.4%**	**21.1%**
MATHEWS / LOCKPORT / LOCKPORT HEIGHTS	9,105	7,905	306	149	34	476	24
		86.8%	**3.4%**	**1.6%**	**0.4%**	**5.2%**	**0.7%**
PORT FOURCHON	32	24	1	3	0	2	2,744
		75.0%	**3.1%**	**9.4%**	**0.0%**	**6.3%**	**11.9%**

3.2 SUMMARY OF RISK

This section summarizes the simulation modeling results projecting coastal flood risk and damage for the Barataria region over a 50-year period in a FWOA. This includes projected storm surge and wave heights, flood depths, exposure of single-family residences, and flood damage. Storm 281 is used to describe impacts within this basin. Storm 281 is a powerful storm which makes landfall near Port Fourchon, but counterclockwise winds push surge from Breton Sound toward the Mississippi River levees. Prior to conducting the FWOA simulations for the Barataria region, the ADCIRC model was updated to include a new alignment in the New Orleans to Venice (NOV) levee system due to be constructed by USACE by 2025.

STORM SURGE AND WAVES

Under both the lower and higher scenarios, the topographic elevations provided by the ICM show land building near the Mid-Barataria Sediment Diversion and in areas adjacent to the Mississippi River, with the rest of the region generally showing increased land subsidence. These results are found in Year 30 and in Year 50. Increased land building corresponds to higher friction for storms traveling over these areas. This increased friction is expected to decrease the ability of storm surge to move inland. In the sparsely populated lower portion of the region near the Mississippi River Delta, this pattern is reversed as land subsidence increases and frictional values show slight decreases. Despite these expected changes in topography and frictional characteristics, ADCIRC simulations predict that SLR is the most influential factor in increasing water levels, storm surge, and waves. Under the lower and higher scenarios, increasing sea level will lead to greater storm surge and peak wave heights in the region.

In both scenarios, ADCIRC simulations show an expansion of the floodplain in the upper portion of the Barataria region. In Year 30, the Upper Barataria region shows a small amount of newly inundated area resulting from the modeled storm. Much of this new inundation is expected to occur in the low-lying wetlands found between Bayou Lafourche and the Mississippi River. This includes several small unincorporated communities near the interaction of U.S. Highway 90 and Bayou des Allemands such as Des Allemands and Bayou Gauche. In addition, communities located along Louisiana Highway 20 between Thibodaux on Bayou Lafourche and Vacherie on the Mississippi River are expected to experience new inundation under both scenarios. This includes the small rural communities of Chackbay and South Vacherie as well communities located between Bayou Lafourche and Lac des Allemands, such as Choctaw and Kraemer. The amount of inundated land in this area is expected to increase substantially by Year 50, particularly across areas that were marsh in Year 0.

FLOOD DEPTH AND DAMAGE

CLARA simulations for the Barataria region show increases in the both the extent and depth of flooding over the 50-year period of analysis in each FWOA scenario. Consistent with the surge and wave results, the most notable change in hazard over time is the expansion of floodplains in the Upper Barataria region, particularly in the low-lying area between Bayou Lafourche and the Mississippi River. Increased mean sea levels along with higher initial water levels in nearby water bodies such as Lake Salvador allow storm surge to push further inland, encroaching upon agricultural lands bordering populated communities along Bayou Lafourche and the Mississippi River and nearly reaching Donaldsonville at the head of Bayou Lafourche. This expansion of the floodplain leads to substantial increases in flood depth and projected damage in communities located this area, such as Chackbay, Luling, Paradis, and South Vacherie. The increase in risk is particularly notable in the Des Allemands area, which sees a sudden increase in projected flood depths over the first 20 years of the analysis period.

Projected economic damage in the Barataria region increases more quickly in the higher scenario than the lower. For unprotected communities, substantial exposure to flooding may result in increases in structural and economic damages approaching 40% in the higher scenario (Figure 58). In the protected polders along the Mississippi River and in the Larose to Golden Meadow Hurricane Protection Project, the CLARA results show abrupt increases in risk over time corresponding to periods when rising sea levels and land subsidence in front of the protection systems result in sudden increases in the likelihood of surge and wave overtopping into the interiors. This results in some of the largest proportional increases in damage from 2020 to 2070. The estimated economic damage in the poldered communities of Cut Off, Galliano, and Golden Meadow jumps by an order of magnitude over the 50-year period of analysis. This is attributable to the protection afforded to these communities by the Larose to Golden Meadow Hurricane Protection Project in the early decades of the period of analysis and the related low initial damage estimates. With the potential for levee overtopping in future years, the risk of structural and economic damage increases.

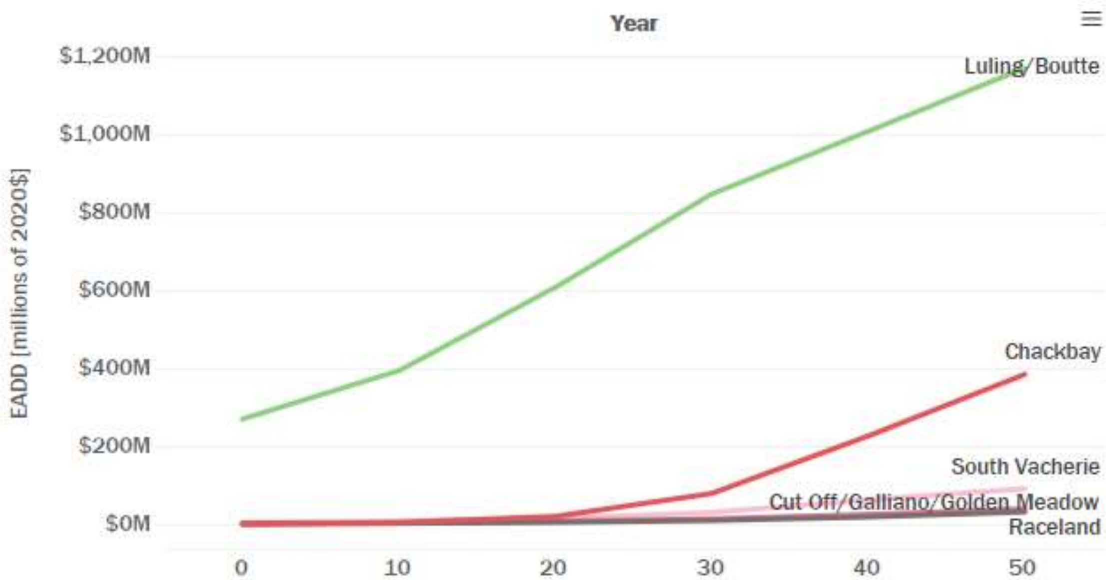

Figure 58. EADD in selected Barataria region communities over the 50-year simulation period under the higher scenario.

Despite being outside the protected polders, other communities along Bayou Lafourche and further up-basin are expected to experience similar proportional increases over time. The agricultural community of Raceland, located on the upper reach of Bayou Lafourche is expected to see estimated annual damages from flooding increase from $40 million to $626 million over 50 years in the higher scenario. Similar patterns of increasing damage are expected in most communities with notable increases in hazard throughout the Barataria region, like Chackbay, Luling, Lockport, and South Vacherie.

3.3 STORM SURGE AND WAVES RESULTS

Prior to the future without action simulations, the Barataria region of the ADCIRC model was updated to include a new alignment in the NOV levee system due to be constructed by USACE. Topography and bathymetry are shown in Figure 59. Additionally, initial conditions land use was interpolated to the model to construct Manning's n (Figure 60), directional wind reduction (Figure 61), and surface canopy coefficients (Figure 62). Updated data is interpolated to the ADCIRC model from the ICM every 10 years. This section shows how the model changes in Year 30 and Year 50 and the associated simulation results.

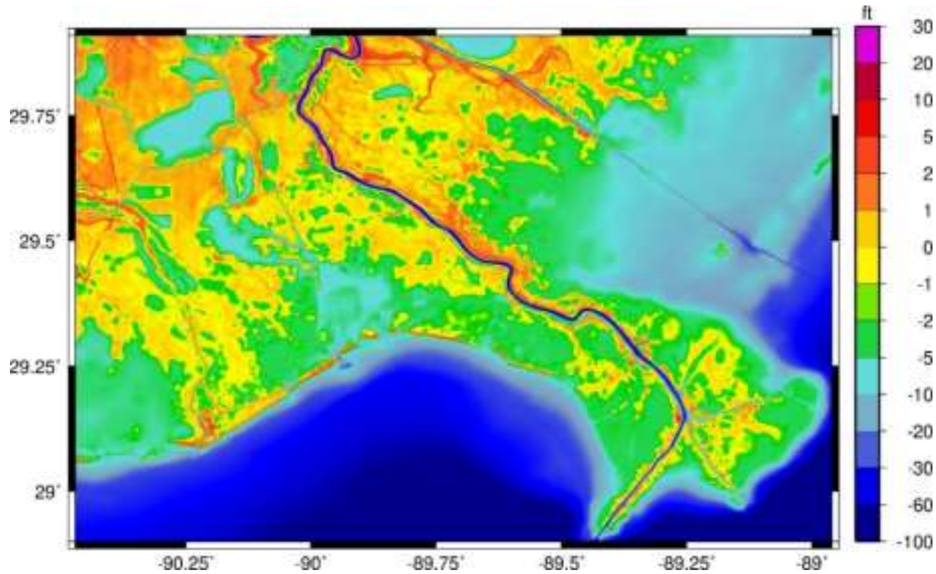

Figure 59. Topography and bathymetry (feet, NAVD88) in ADCIRC at Year 0.

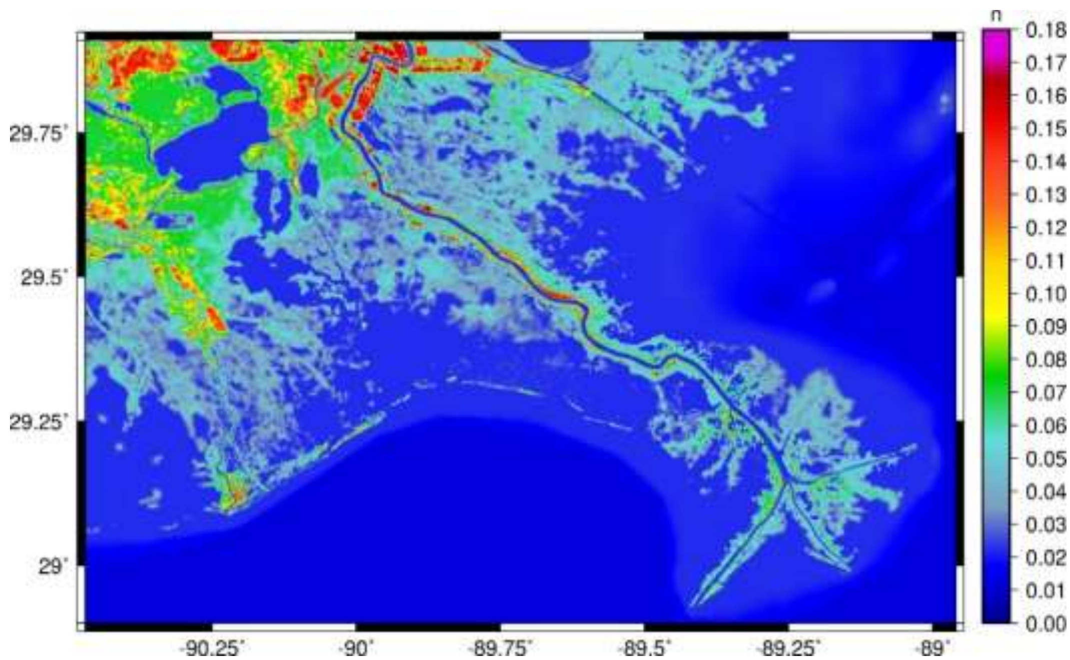

Figure 60. Manning’s n coefficient in ADCIRC at Year 0.

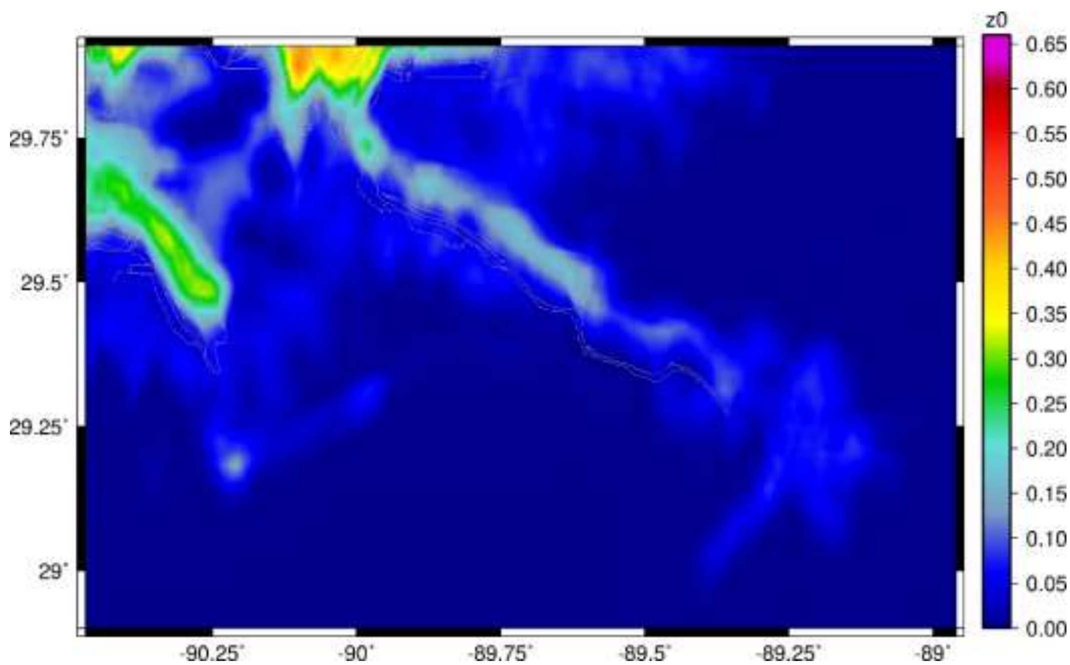

Figure 61. Directional wind reduction coefficient for a wind blowing from the south in ADCIRC at Year 0.

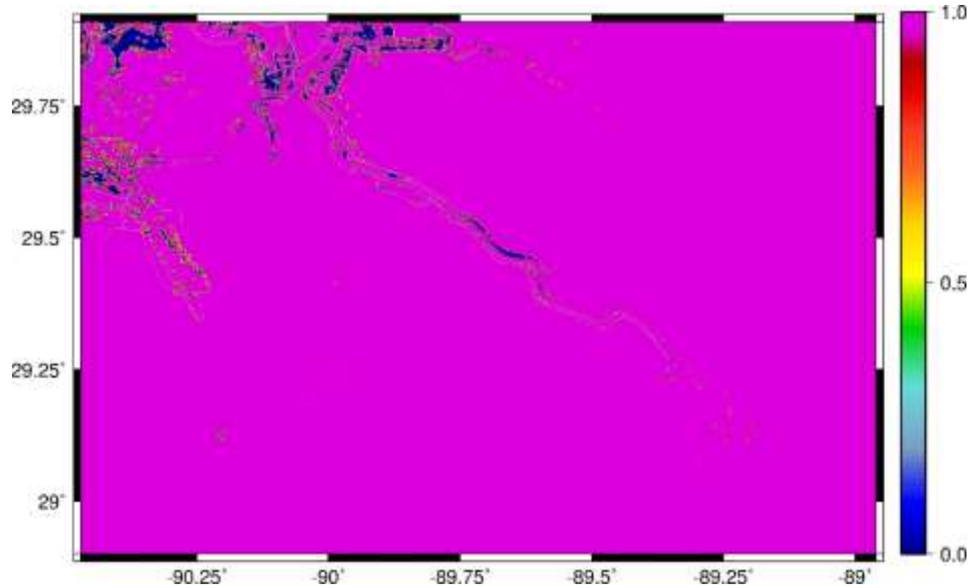

Figure 62. Surface canopy coefficient in ADCIRC at Year 0.

Storm 281 is used to describe impacts within this basin. Storm 281 is a powerful storm which makes landfall near Port Fourchon, but counterclockwise winds push surge from Breton Sound toward the Mississippi River levees. The peak surge elevation and peak wave height in Year 0 for Storm 281 is shown in Figure 63 and Figure 64.

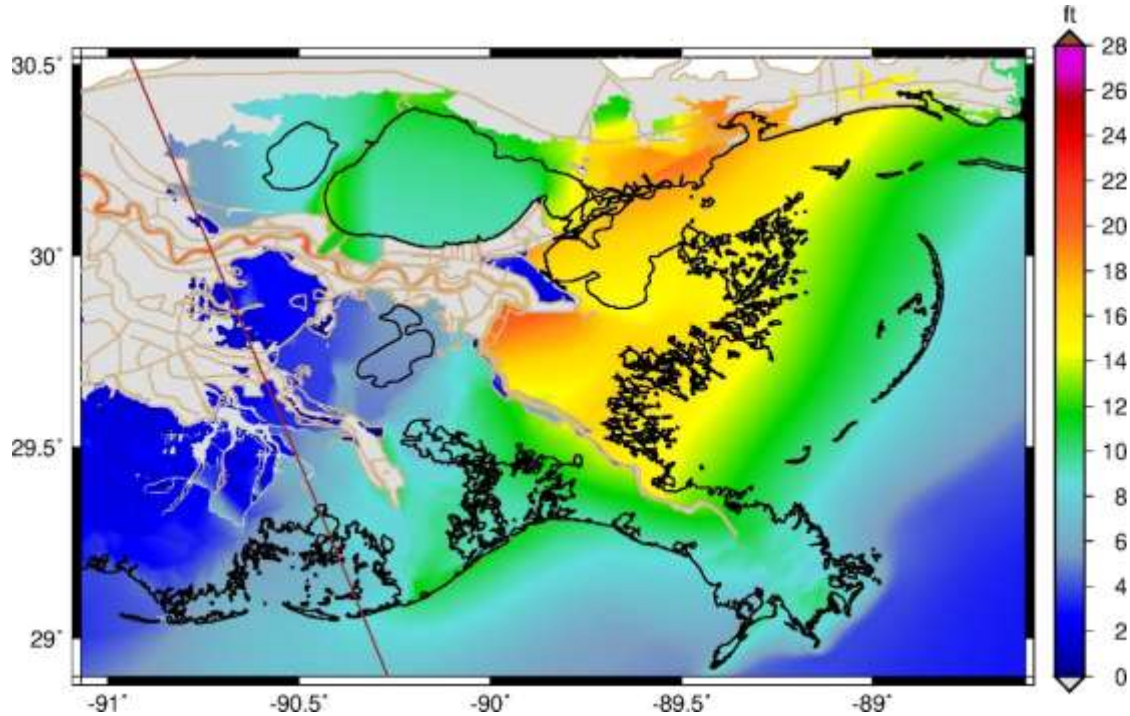

Figure 63. Peak water surface elevation for Storm 281 simulated in Year 0.

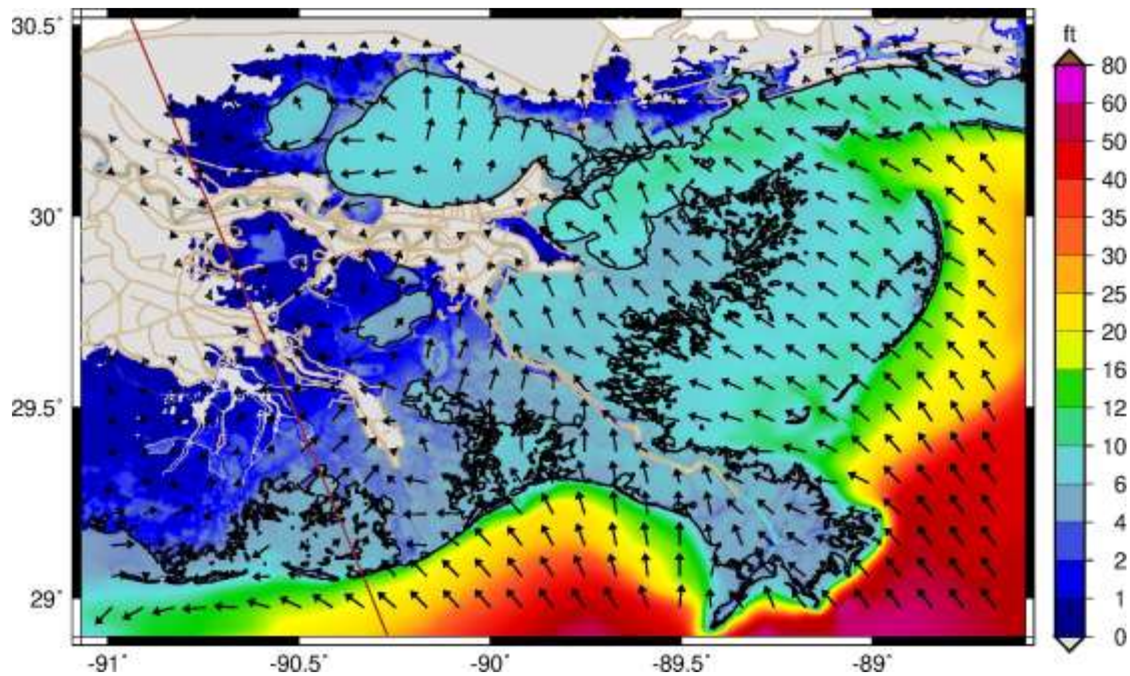

Figure 64. Peak wave height (feet) for Storm 281 in Year 0.

LOWER SCENARIO

In Year 30 and Year 50, the topographic elevations provided by the ICM show land building near both diversions and in areas adjacent to the Mississippi River (Figure 65, Figure 68). The rest of the region generally shows subsidence. Frictional values near the Mississippi River Delta show slight decreases while areas near the diversions show increases in friction due to land building (Figure 66, Figure 67, Figure 69, and Figure 70). Additional details about the changes in topography, bathymetry, and land use characteristics can be found in White et al. (2023).

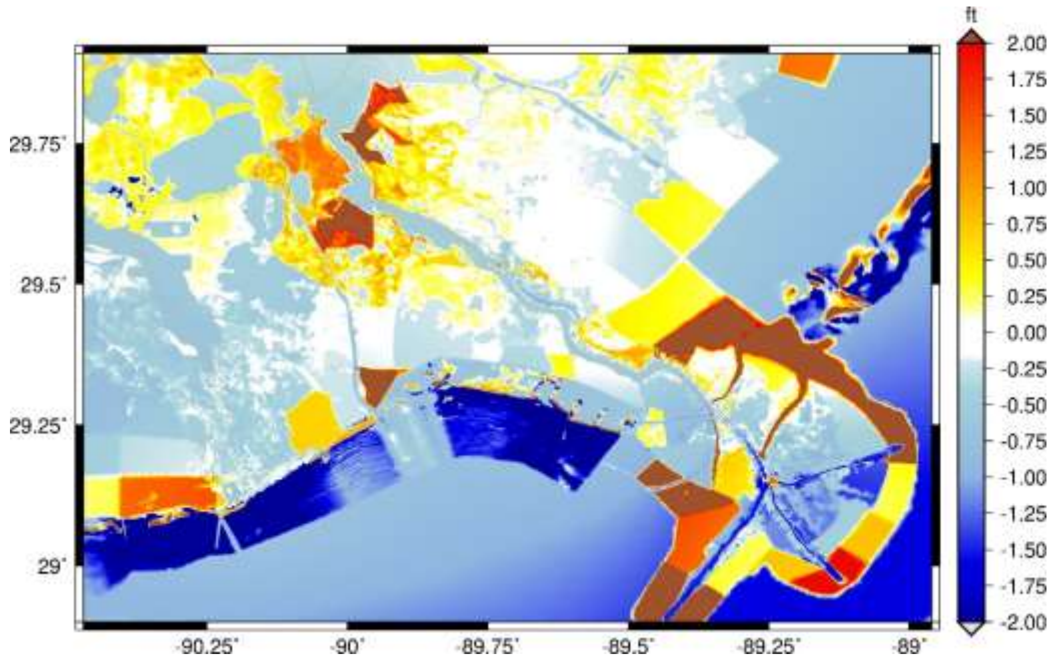

Figure 65. Change in topography and bathymetry in ADCIRC in the lower scenario for Year 30.

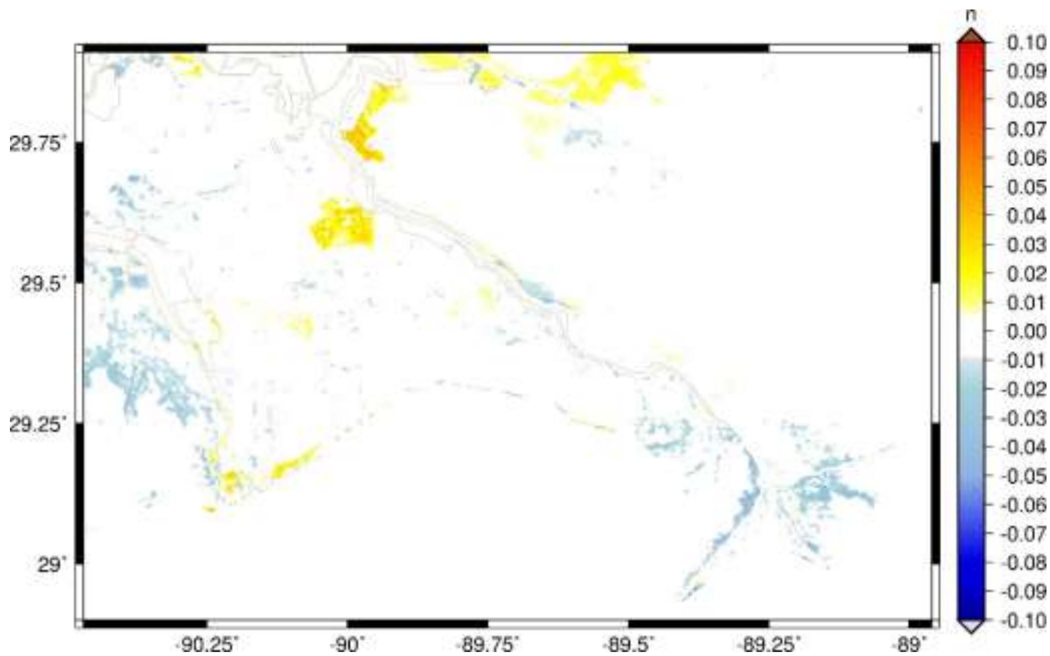

Figure 66. Change in Manning's n coefficient in ADCIRC in the lower scenario for Year 30.

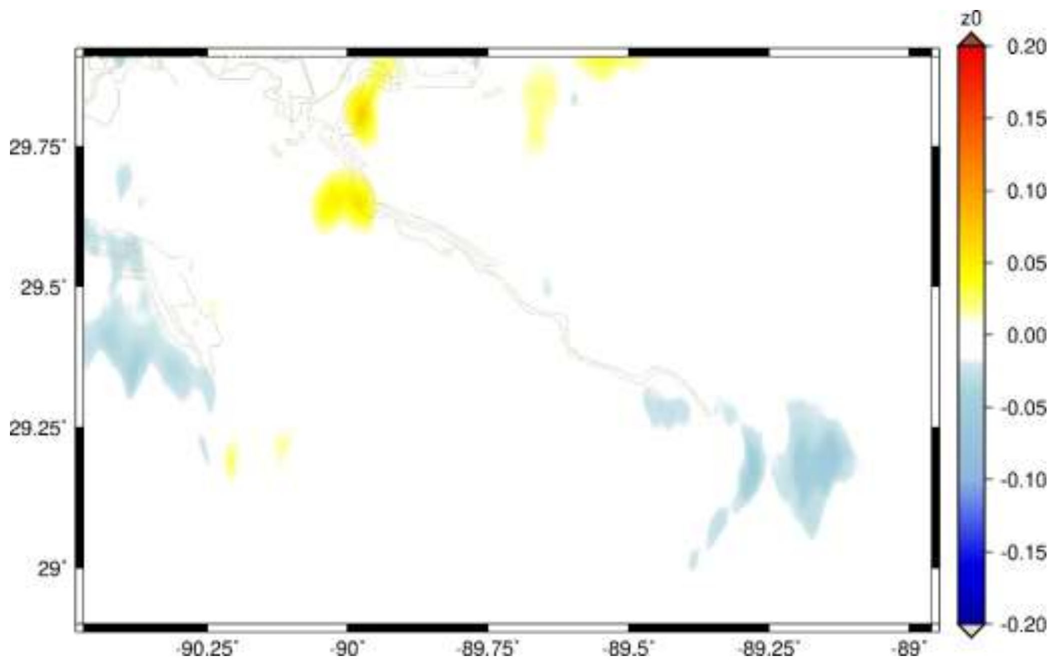

Figure 67. Change in directional wind reduction in ADCIRC in the lower scenario in Year 30.

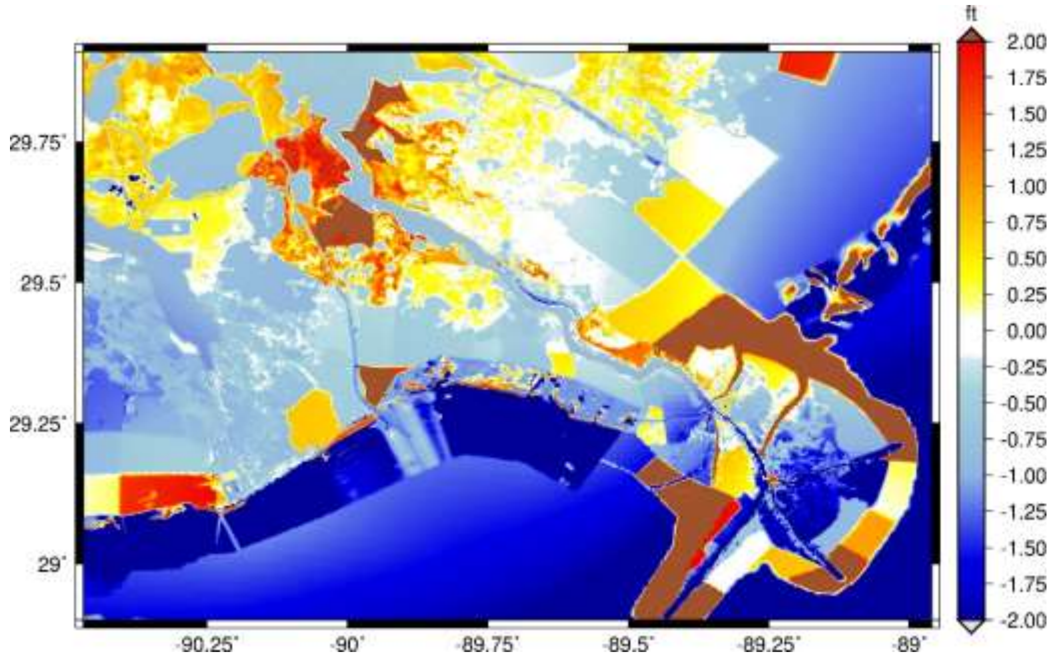

Figure 68. Change in topography and bathymetry in ADCIRC in the lower scenario for Year 50.

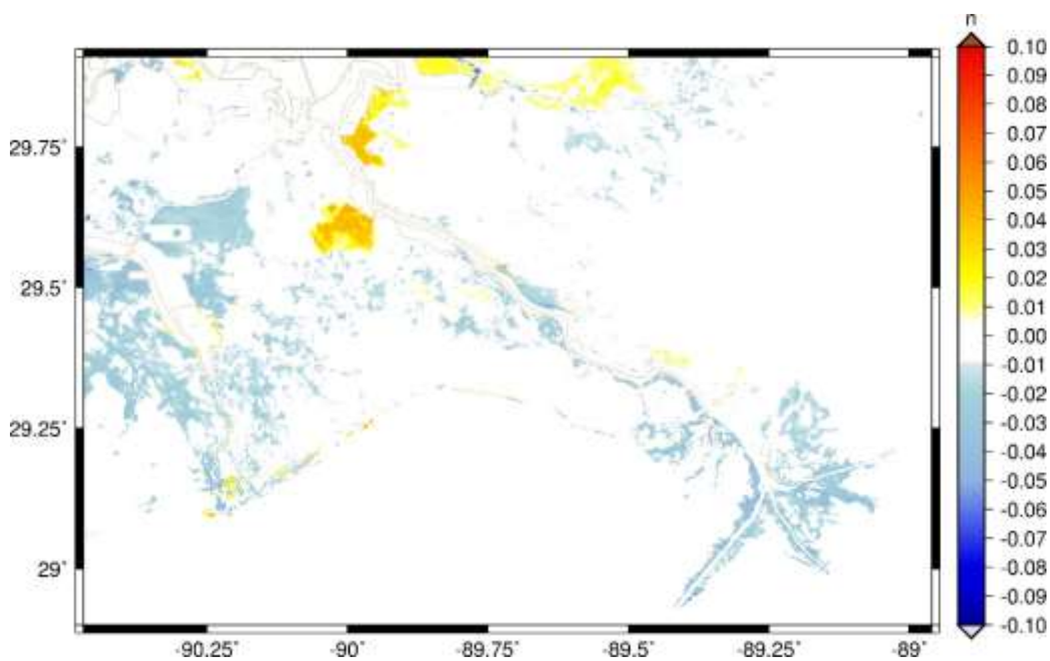

Figure 69. Change in Manning's n coefficient in ADCIRC in the lower scenario for Year 50.

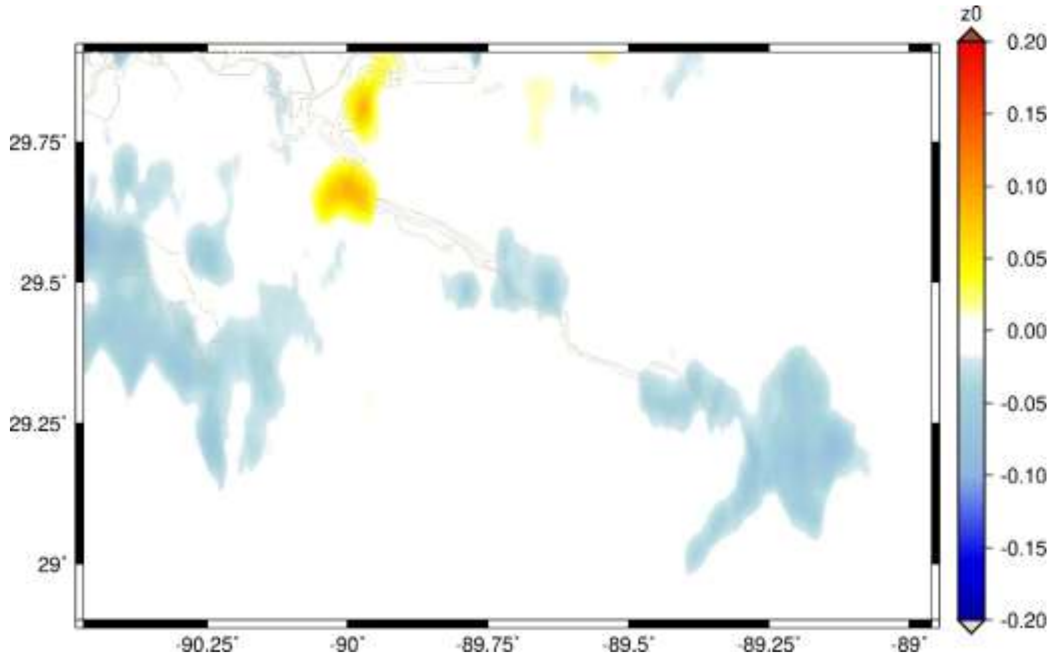

Figure 70. Change in directional wind reduction in ADCIRC in the lower scenario in Year 50.

Changes in storm surge and waves are most influenced by the SLR increment rather than changes to topography or frictional characteristics. Figure 71 and Figure 73 show the change in peak water level in Year 30 and Year 50 and Figure 72 and Figure 74 show the change in peak wave height. The offshore color shown in the plots aligns with the SLR increment. Colors warmer than this offshore value indicate a nonlinear response where the change in the peak water surface elevation is greater than that of the SLR increment. Areas in dark brown show newly inundated areas. The Upper Barataria region shows a small amount of newly inundated area for this storm in Year 30, which increases substantially by Year 50.

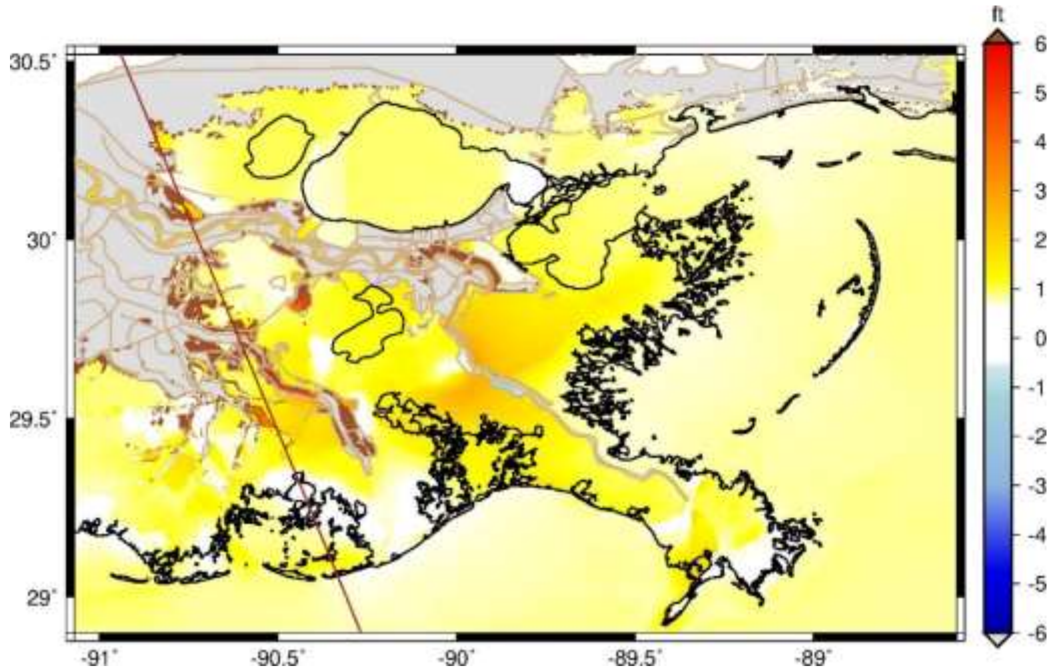

Figure 71. Change in peak water surface elevation between Year 30 and Year 0 in the lower scenario.

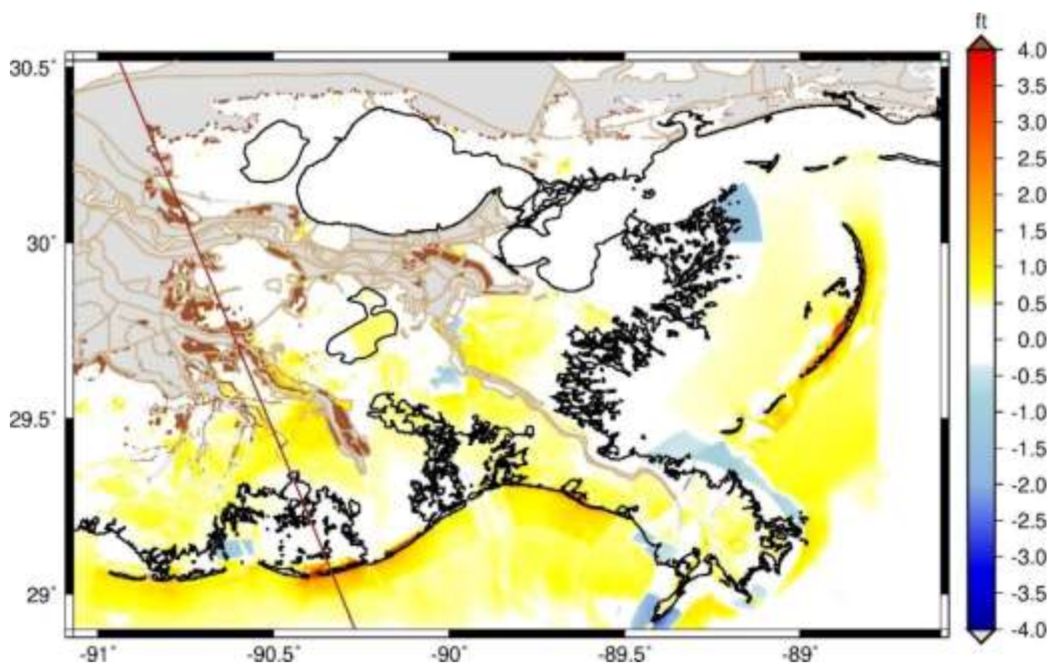

Figure 72. Change in peak wave height elevation between Year 30 and Year 0 in the lower scenario.

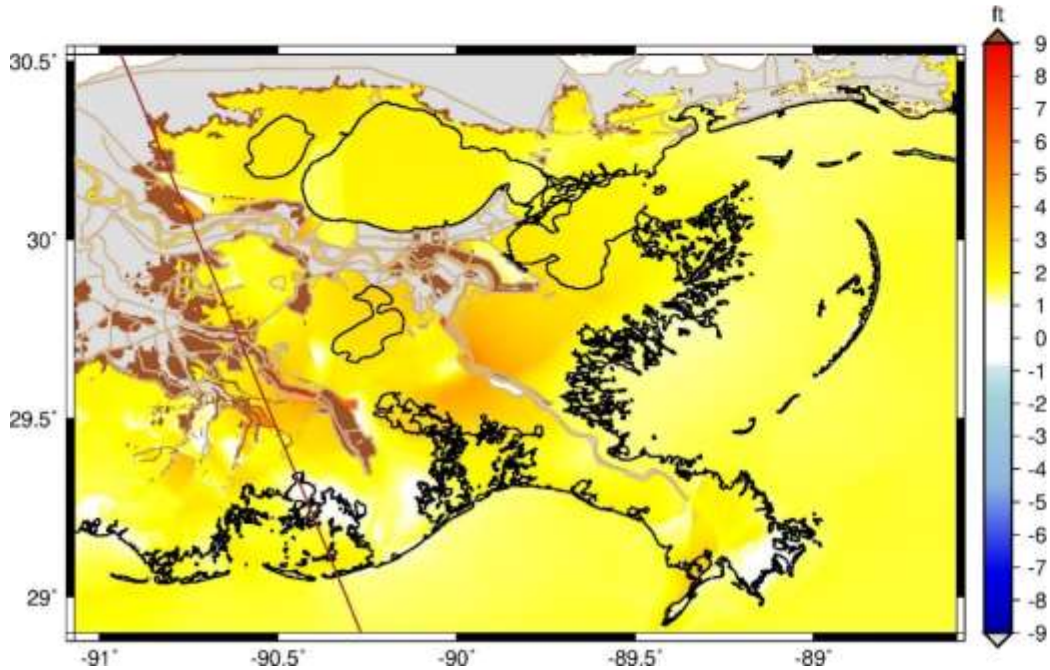

Figure 73. Change in peak water surface elevation between Year 50 and Year 0 in the lower scenario.

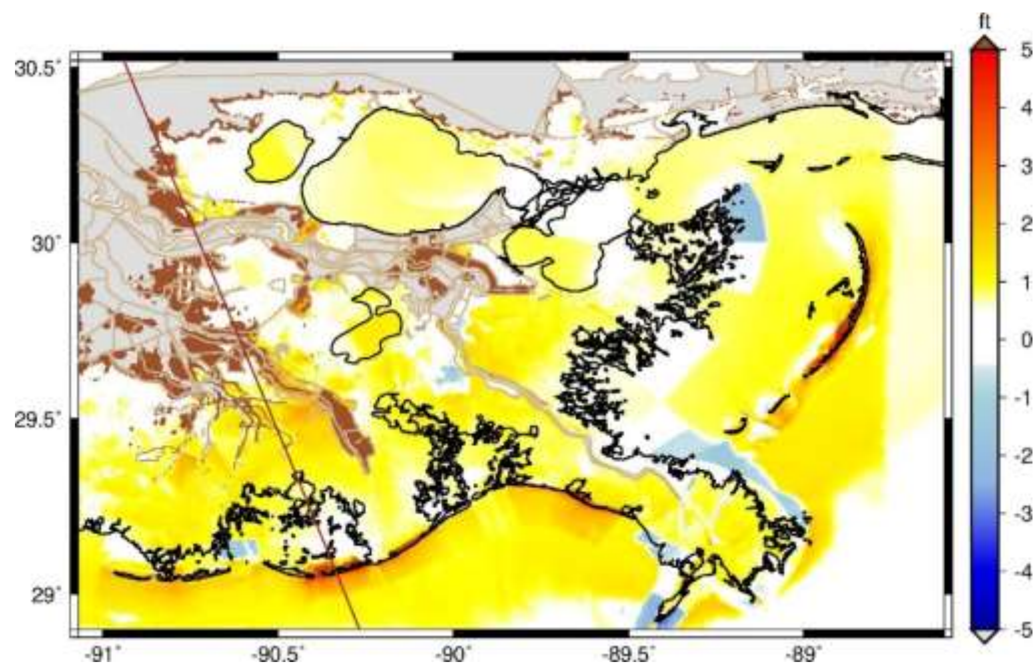

Figure 74. Change in peak wave height between Year 50 and Year 0 in the lower scenario.

HIGHER SCENARIO

In Year 30 and Year 50, the topographic elevations provided by the ICM show land building near both diversions and in areas adjacent to the Mississippi River (Figure 75, Figure 77). The rest of the region generally shows subsidence. Compared with the lower scenario, there is lower friction across areas that were marsh in Year 0 (Figure 76, Figure 78). Additional details about the changes in topography, bathymetry, and land use characteristics can be found in White et al. (2023).

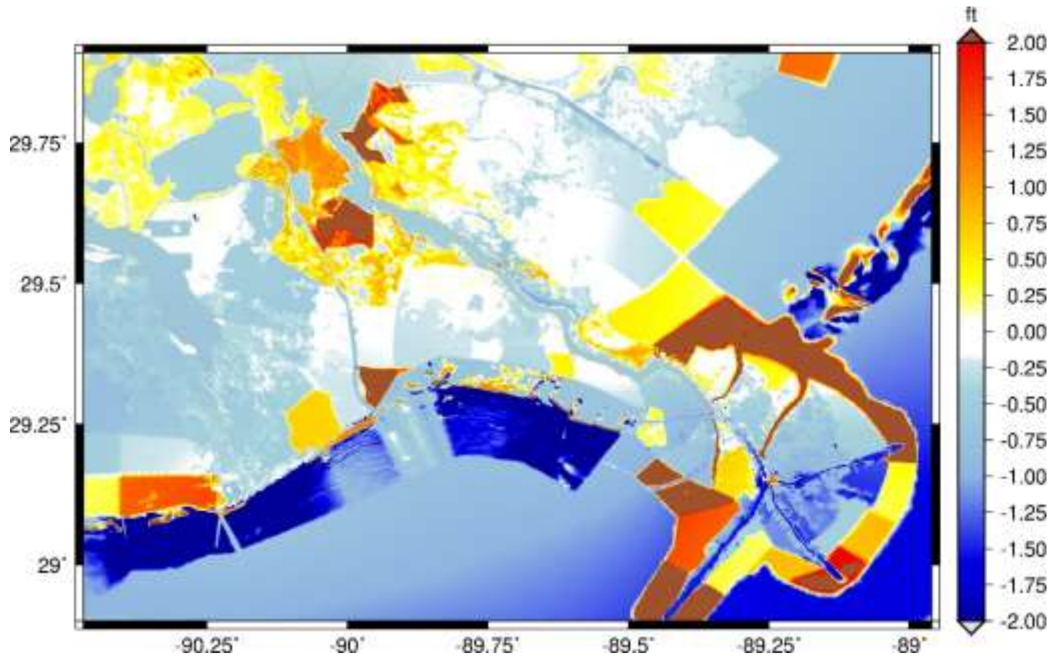

Figure 75. Change in topography and bathymetry in ADCIRC in the lower scenario for Year 30.

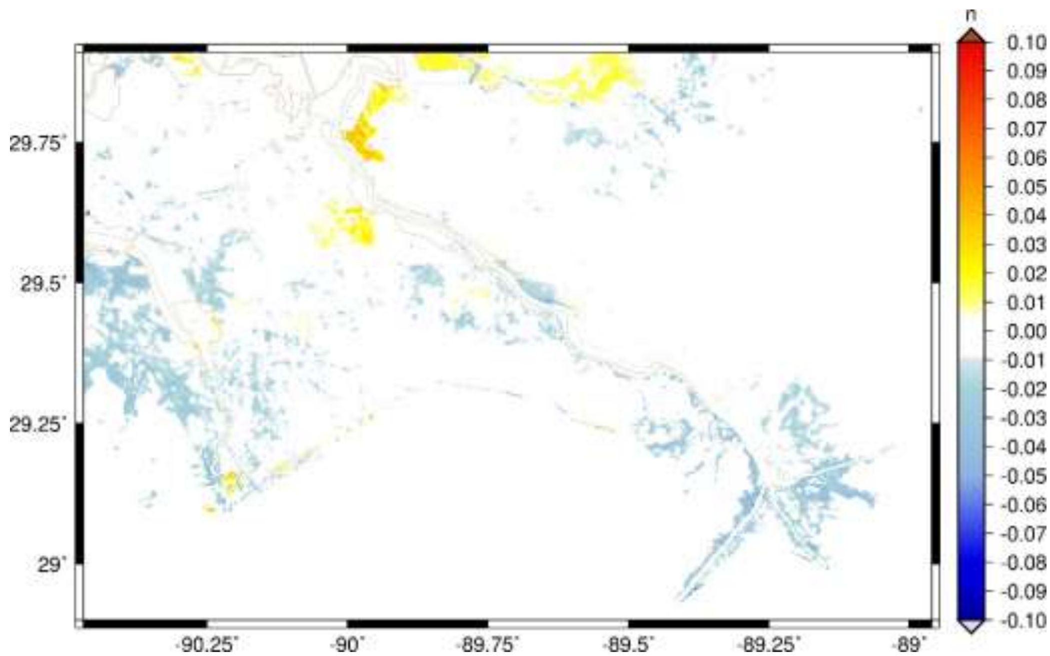

Figure 76. Change in Manning's n coefficient in ADCIRC in the higher scenario for Year 30.

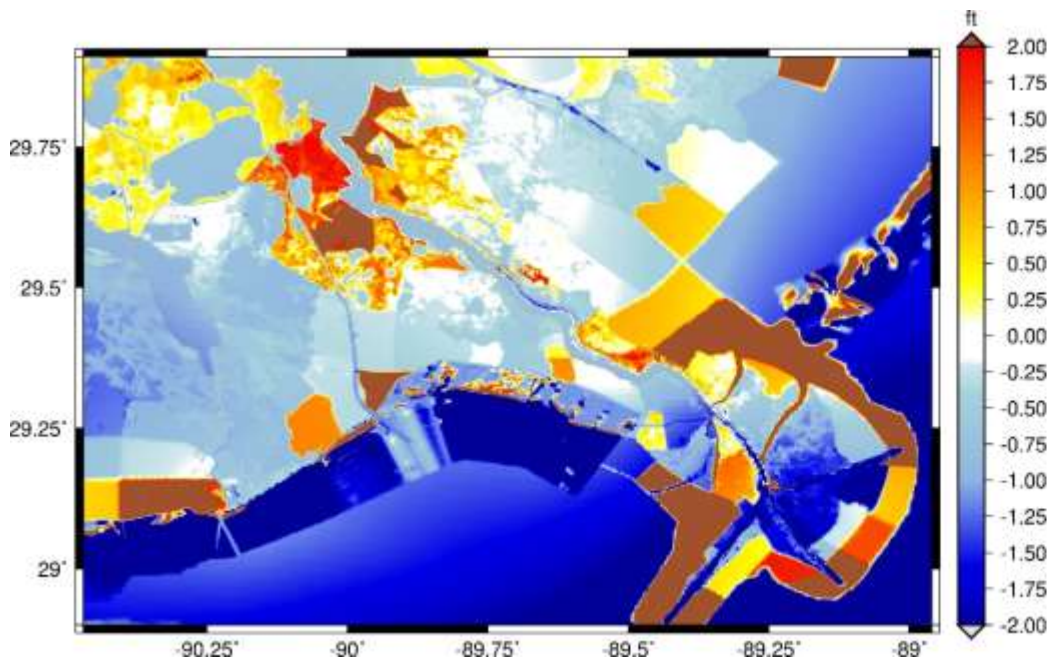

Figure 77. Change in topography and bathymetry in ADCIRC in the higher scenario for Year 50.

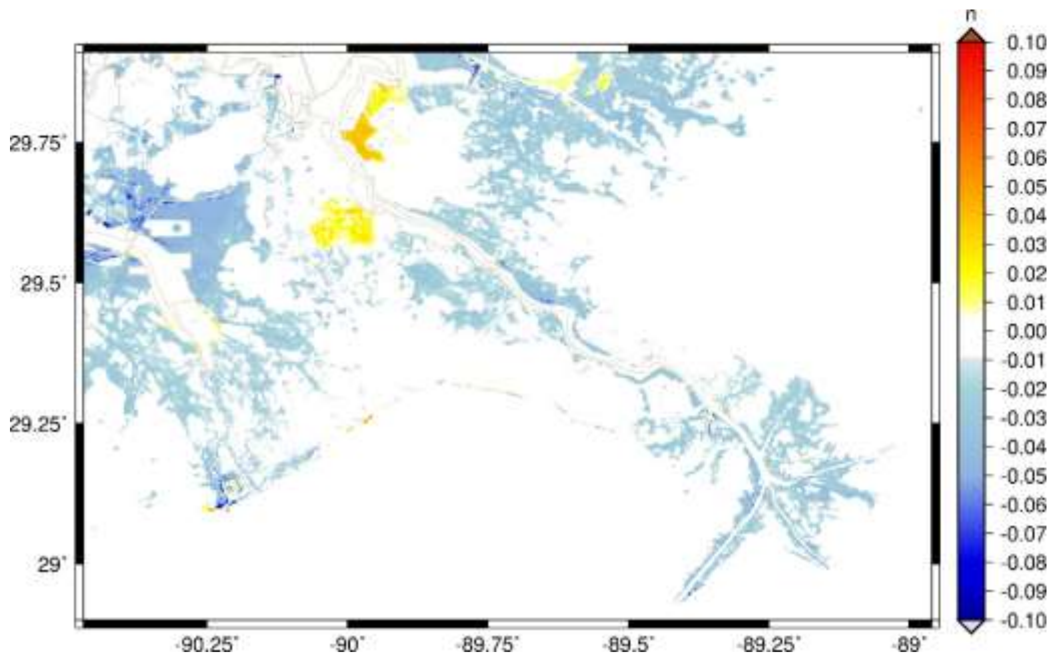

Figure 78. Change in Manning's n coefficient in ADCIRC in the higher scenario for Year 50.

Changes in storm surge and waves are most influenced by the SLR increment rather than changes to topography or frictional characteristics. Figure 79 and Figure 81 show the change in peak water level in Year 30 and Year 50 and Figure 80 and Figure 82 show the change in peak wave height. The offshore color shown in the plots aligns with the SLR increment. Colors warmer than this offshore value indicate a nonlinear response where the change in the peak water surface elevation is greater than that of the SLR increment. Areas in dark brown show newly inundated areas. Like in the lower scenario, the Upper Barataria region shows an expansion of the floodplain. The higher SLR increment in the higher scenario shows a further expansion of the floodplain when compared to the lower scenario.

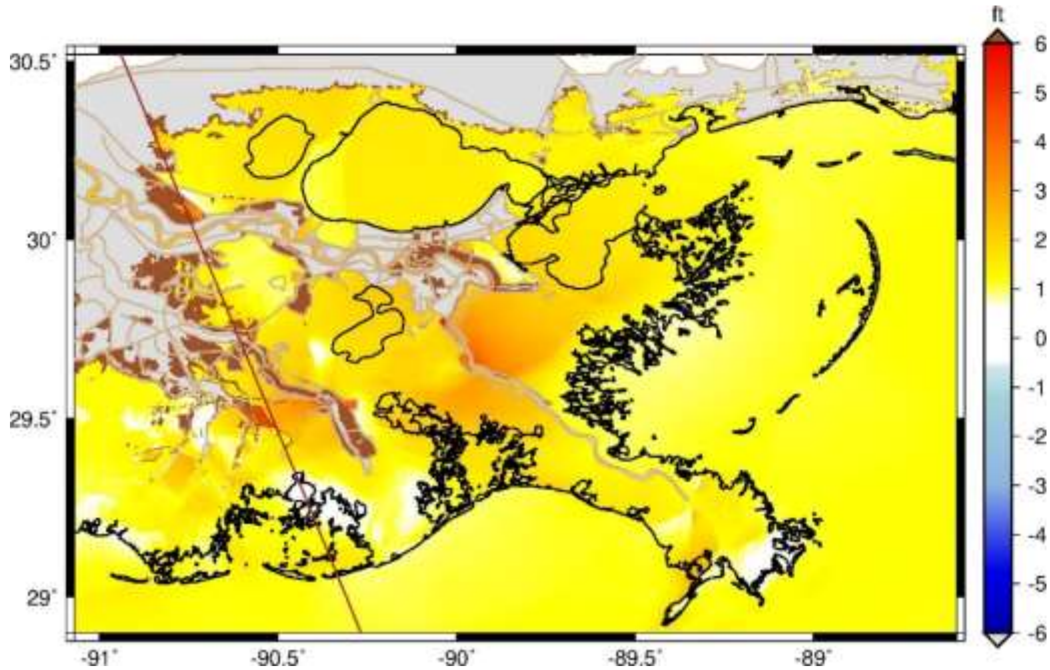

Figure 79. Change in peak water surface elevation between Year 30 and Year 0 in the higher scenario.

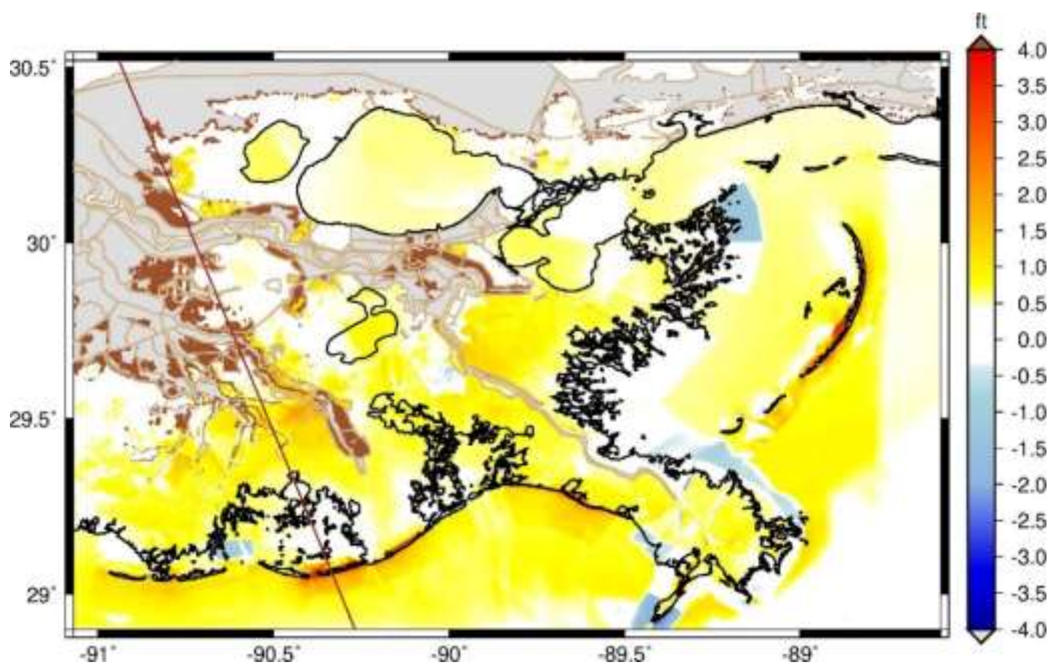

Figure 80. Change in peak wave height between Year 30 and Year 0 in the higher scenario.

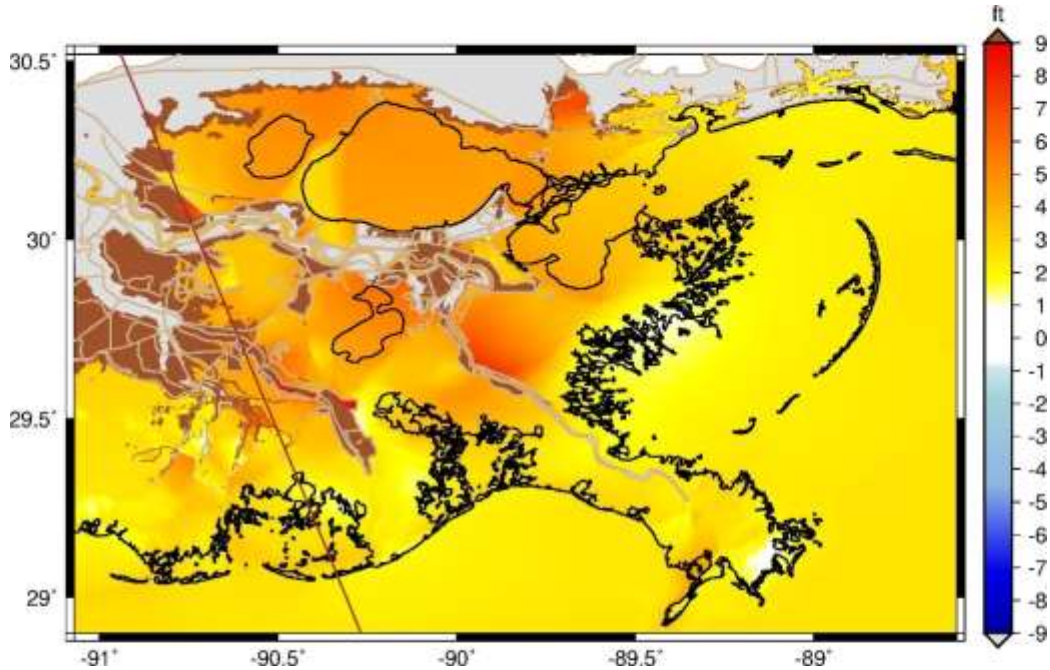

Figure 81. Change in peak water surface elevation between Year 50 and Year 0 in the higher scenario.

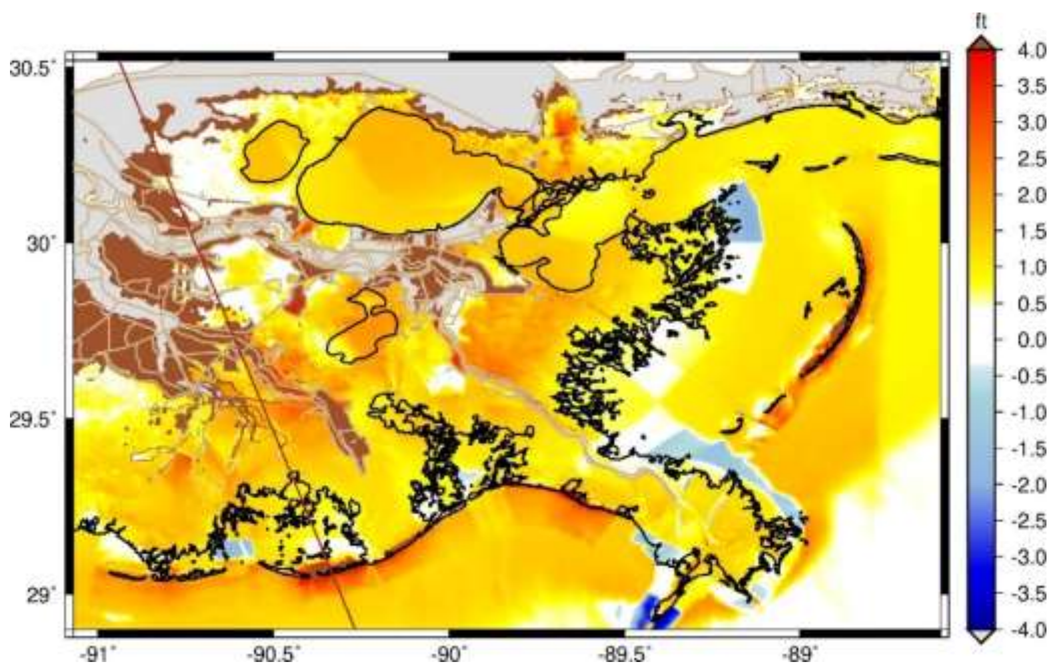

Figure 82. Change in peak wave height elevation between Year 50 and Year 0 in the higher scenario.

3.4 FLOOD DEPTH PROJECTIONS

LOWER SCENARIO

Figure 83 shows the projected 10% annual chance (1 in 10-year) flood depths for Barataria in the lower scenario of a FWOA (years 20 through 50). In Year 20, these depths are less than 10 feet everywhere in the basin except for selected areas in front of the Larose to Golden Meadow Hurricane Protection Project and levees along the west bank of the Mississippi River in lower Plaquemines Parish. In those areas, storm surge can pile up as it encounters the levee systems, resulting in greater inundation.

Over time, the 10% AEP flood depths generally increase by a foot or less per decade (Figure 84). The most noticeable increase is in the extent of the floodplain in the Upper Barataria Basin, roughly defined as being north and west of Lake Salvador. This area is mostly unpopulated except for the ridge following Bayou Lafourche and along the riverbanks; the floodplain does, however, reach parts of South Vacherie in years 40 and 50.

Some parts of the poldered area of lower Plaquemines Parish communities on the west bank of the Mississippi experience flooding of 1-4 feet with a 10% annual chance. This flooding, between Myrtle Grove and Port Sulphur, is primarily due to rainfall. The communities enclosed by the Larose to Golden Meadow Hurricane Protection Project, on the other hand, avoid flooding at the 1 in 10-year return period, even through Year 50.

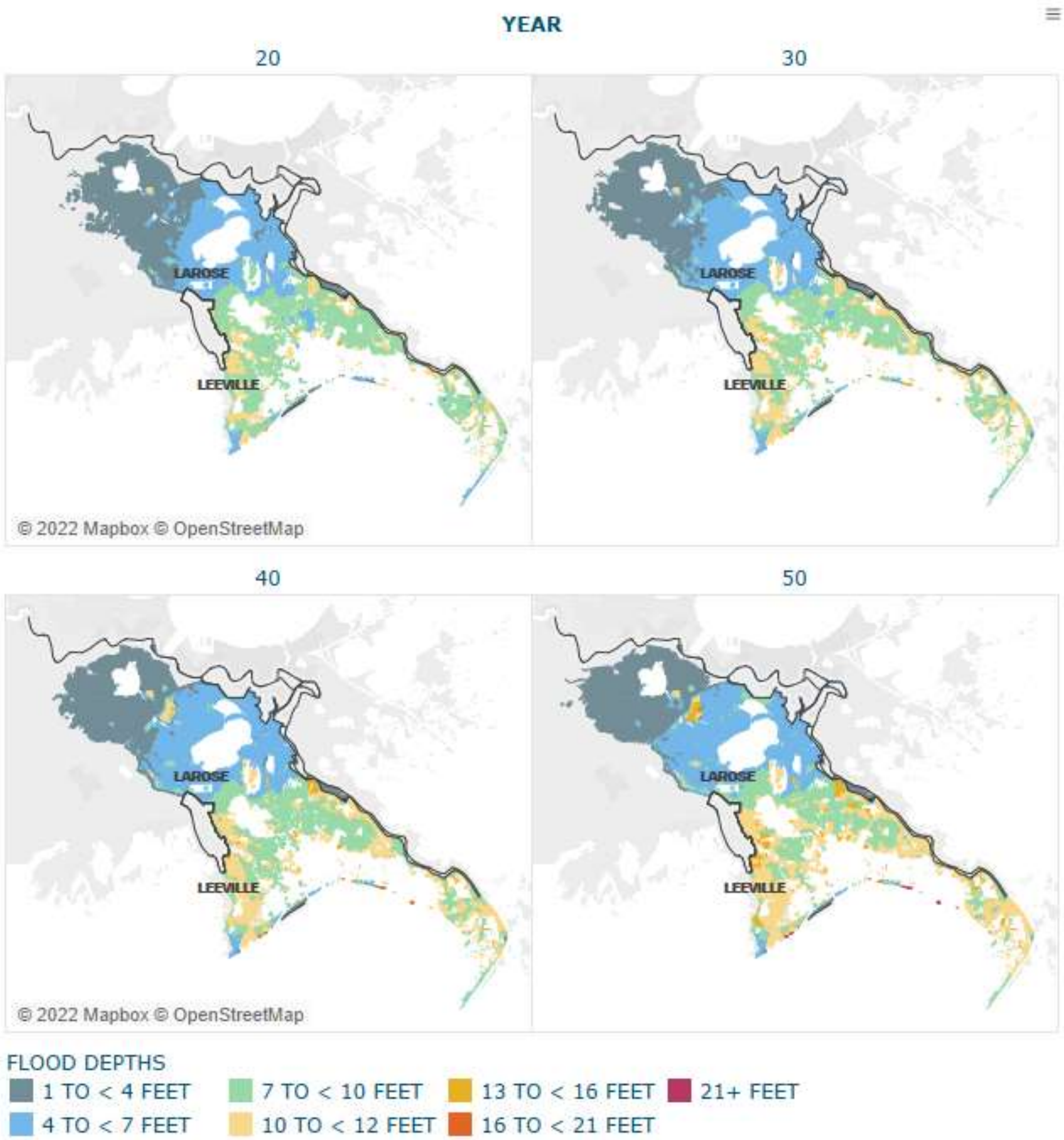

Figure 83. 10% annual chance (1 in 10-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

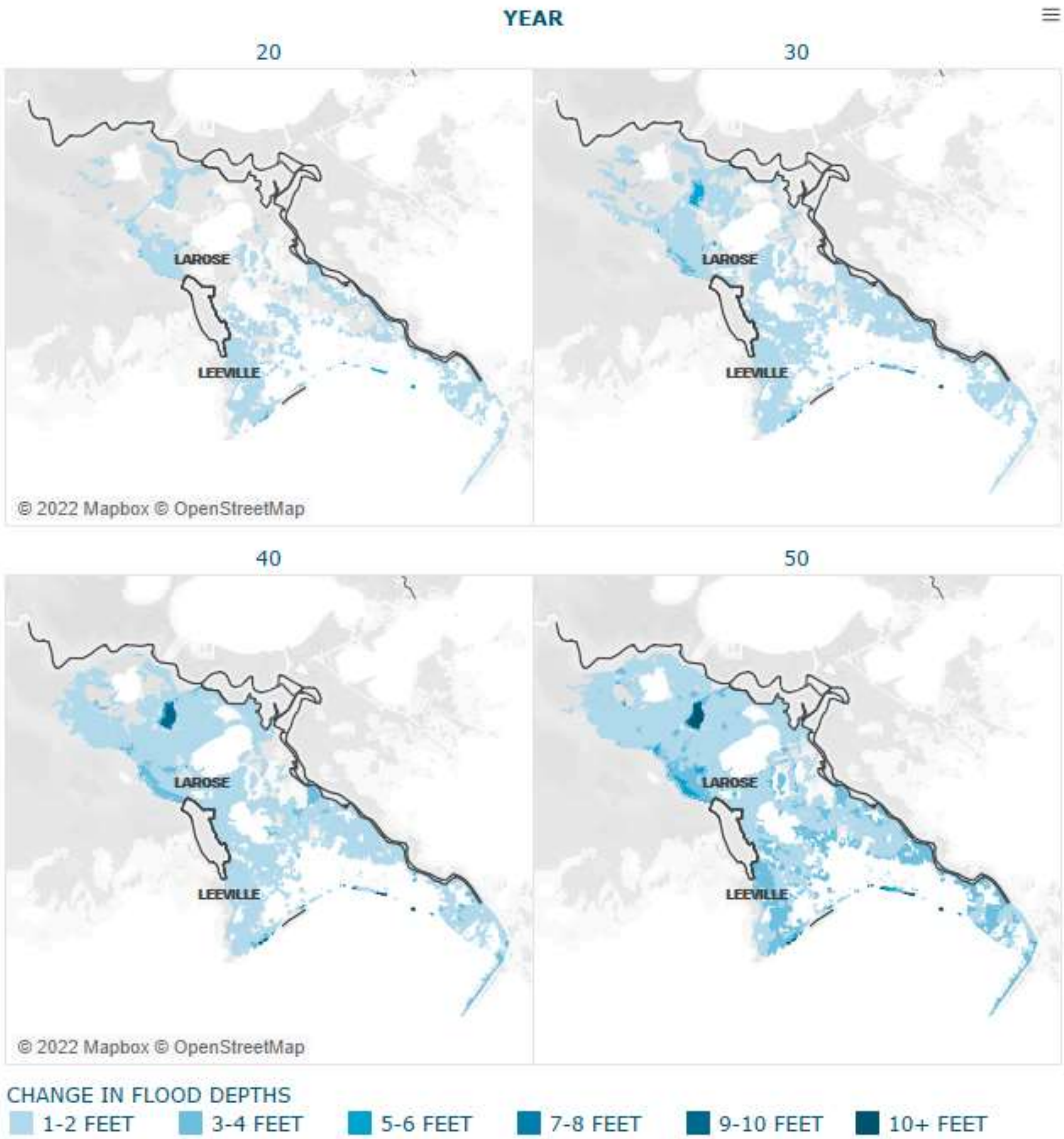

Figure 84. Change in 10% annual chance (1 in 10-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

In Year 20, the extent of the 1% AEP floodplain reaches Thibodaux along the bayou (Figure 85). These depths are over 10 feet in the unprotected areas between the Larose to Golden Meadow Hurricane Protection Project and the west bank of the Mississippi River, with generally greater depths in the region closer to the river. Over time, the floodplain penetrates further up-basin, eventually reaching St. James. Depths of approximately 1 foot in South Vacherie at Year 20 increase to approximately 4 feet by Year 50.

While the Larose to Golden Meadow Hurricane Protection Project does provide protection from 1 in 100-year flooding through Year 20, future decades do see a small amount of inundation (1-4 feet) from storm surge and wave overtopping. Flooding in the lower Plaquemines polders is still predominantly between Myrtle Grove and Port Sulphur, and its magnitude is from 4 to 7 feet.

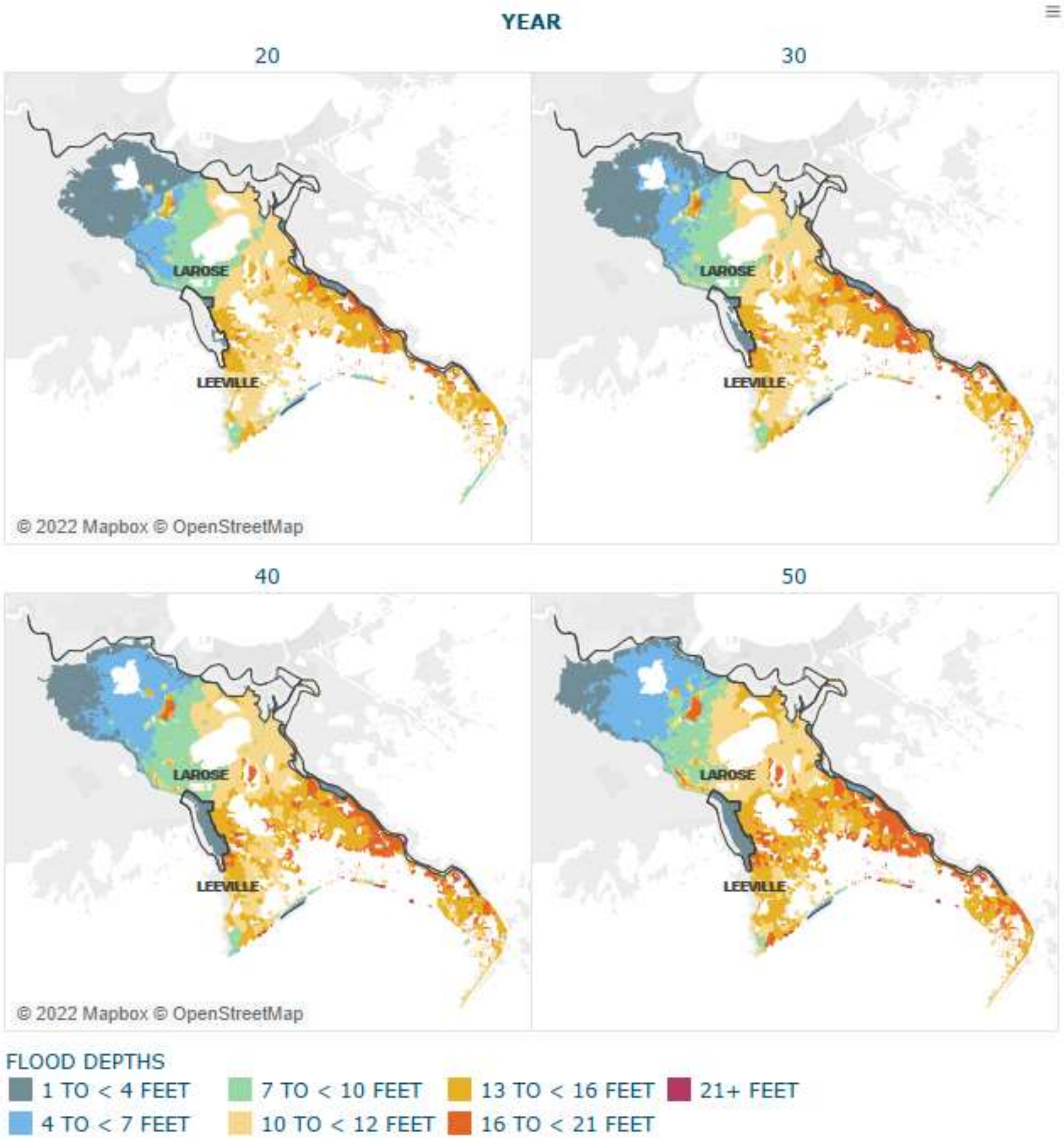

Figure 85. 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

That inundation in Plaquemines Parish remains relatively constant over time. This is explained by smaller increases in 1 in 100-year exceedances near the west bank of the river southeast of New Orleans than in many other parts of the basin (Figure 86). The largest increases over time occur in Upper Barataria along the bayou northwest of Larose and in the Des Allemands and Bayou Gauche area between Lake Salvador and Lac des Allemands.

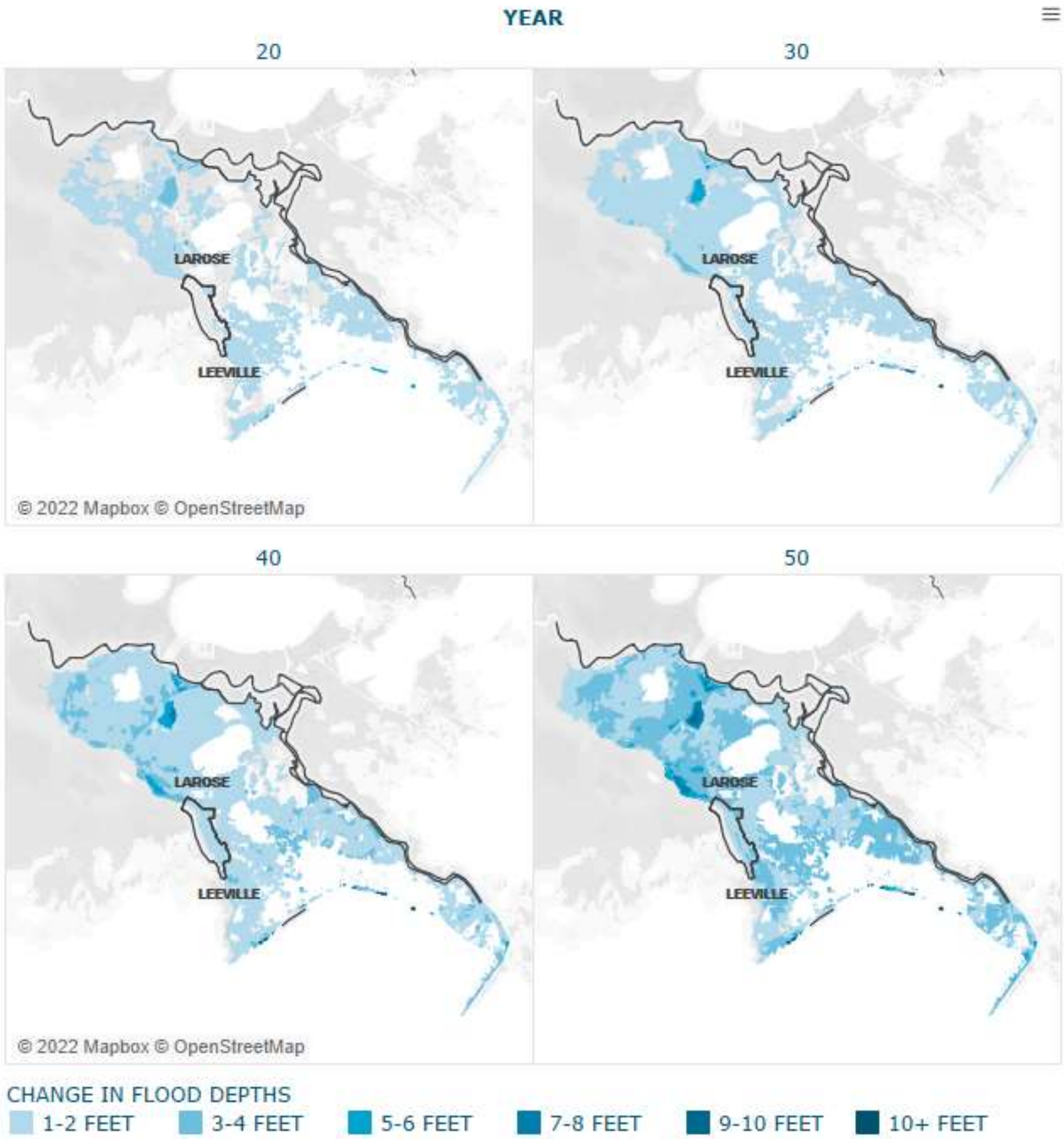

Figure 86. Change in 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

HIGHER SCENARIO

In the higher scenario, Barataria flood depths with a 10% annual chance of occurrence extend farther than in the lower scenario. In the latter, inundation does not generally cross over State Highway 3127 near the Westbank, west of HSDRRS. However, in the higher scenario by Year 50, the 1 in 10-year floodplain extends to the Westbank levees in the area around Luling (Figure 87). The 10% AEP floodplain also pushes substantially farther west, approaching Donaldsonville, although it remains predominantly contained to uninhabited wetlands.

Flood depths in the Plaquemines polder between Myrtle Grove and Port Sulphur are very similar between the scenarios, with a consistent 2-3 feet of flooding across time periods. As expected, no flooding is seen with in the Larose to Golden Meadow Hurricane Protection Project at this return period. Grand Isle experiences 3-4 feet of flooding as storm surge passes inland, where inundation eventually peaks around 10-13 feet between the Larose to Golden Meadow and Myrtle Grove polders.

The changes in 1 in 10-year flooding are largest in the Des Allemands area, as the local levee on its eastern edge along the Grand Bayou Canal loses its ability to protect the community over time. Other notable increases are along Bayou Lafourche north of Larose (Figure 88), with some grid cells increasing at a rate of 1.5 to 2 feet per decade. However, in most areas, the rate of increase is more modest, generally less than 1 foot per decade.

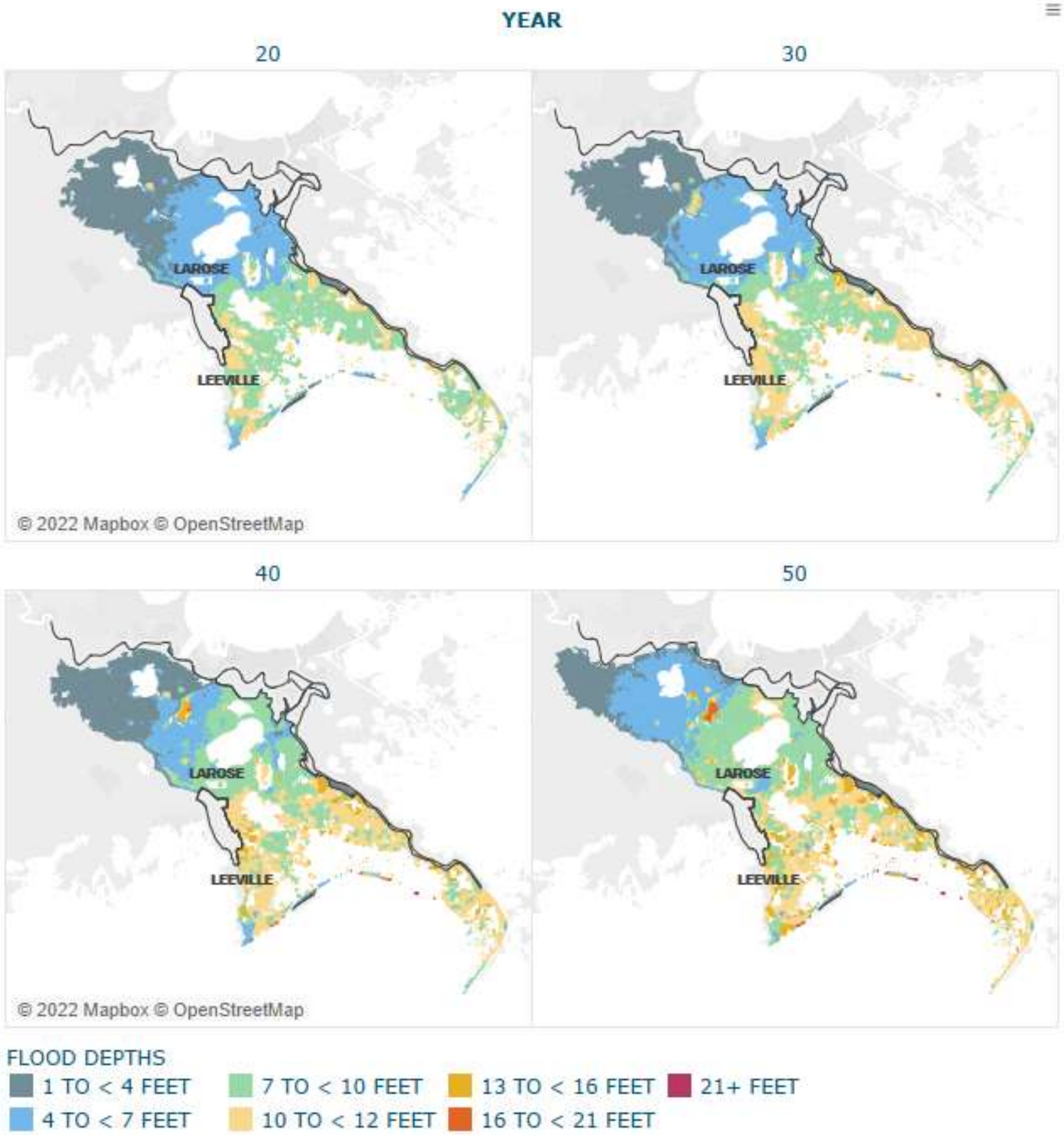

Figure 87. 10% annual chance (1 in 10-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

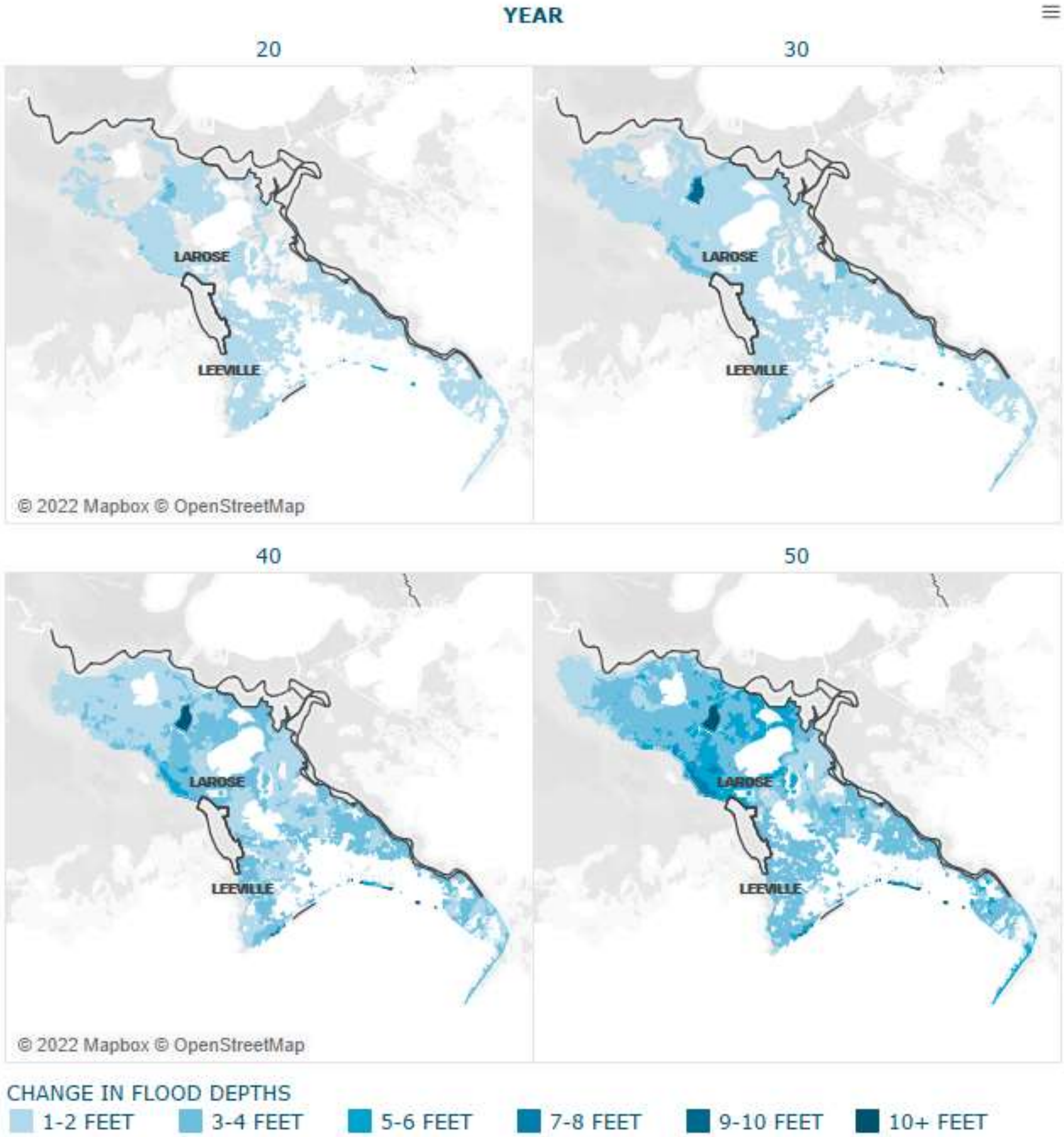

Figure 88. Change in 10% annual chance (1 in 10-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The overall spatial pattern of 1% annual chance flood depths in Barataria, in terms of regions with lesser or greater inundation, is very similar to that of the 10% annual chance depths (Figure 89). As in the lower scenario, the main difference is an expansion of the floodplain up-basin, with inundation further encroaching upon agricultural lands bordering populated communities along Bayou Lafourche and the Mississippi River banks west of New Orleans. By Year 50, 1 in 100-year flood depths inundate much of Thibodaux and Vacherie. The Larose to Golden Meadow Hurricane Protection Project provides 1 in 100-year protection under initial conditions, but this protection fades over time, with flood depths reaching 3-4 feet in many areas by Year 50. Flooding on Grand Isle ranges from 5 to 8 feet consistently over time.

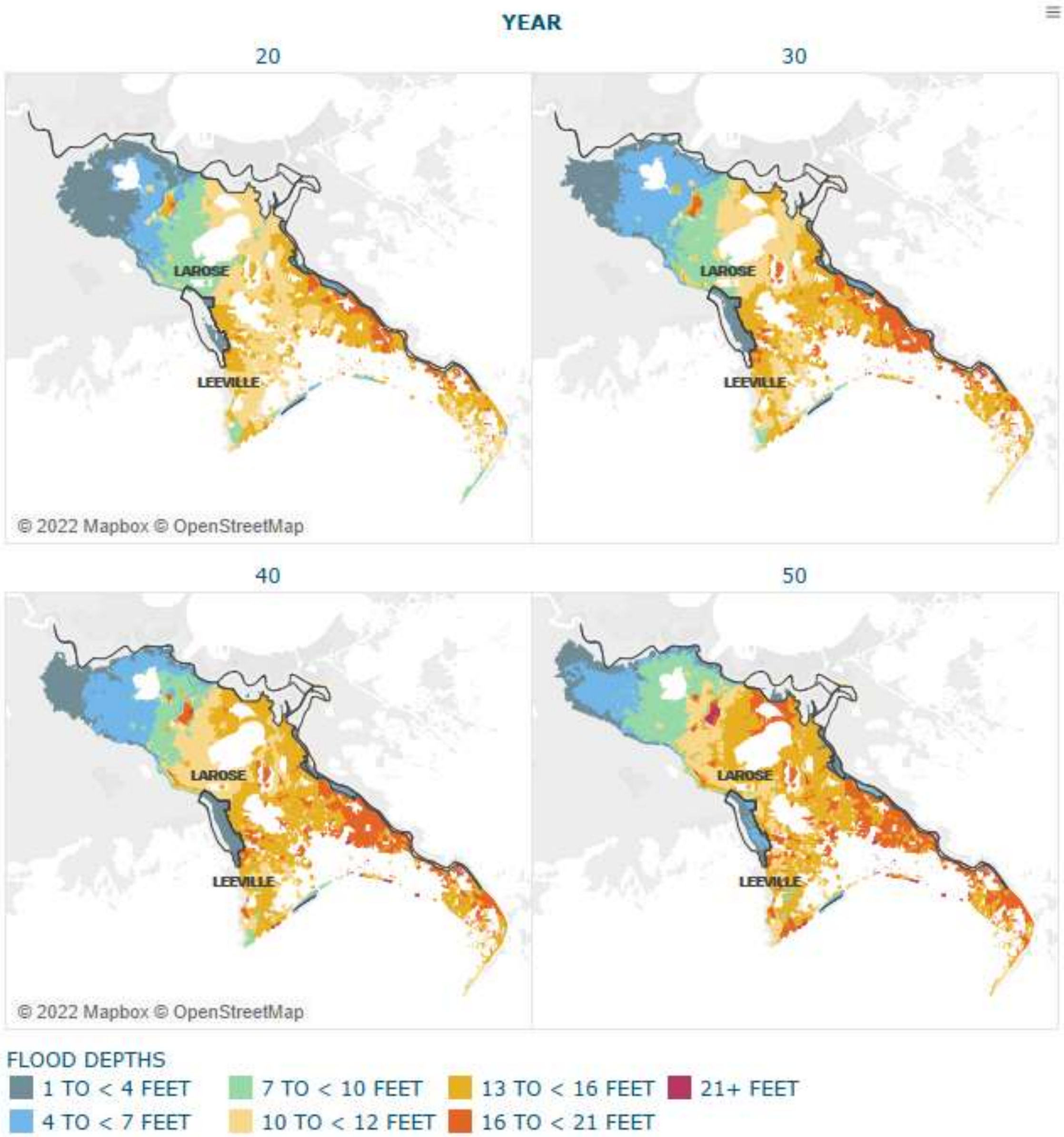

Figure 89. 1% annual chance (1 in 100-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

In the lower basin, 1% AEP depths increase by roughly 0.5-1 feet per decade, with a corresponding increase of 1-1.5 feet per decade in the upper basin (Figure 90). The greatest increases over time are located in Des Allemands, Luling, and along Bayou Lafourche.

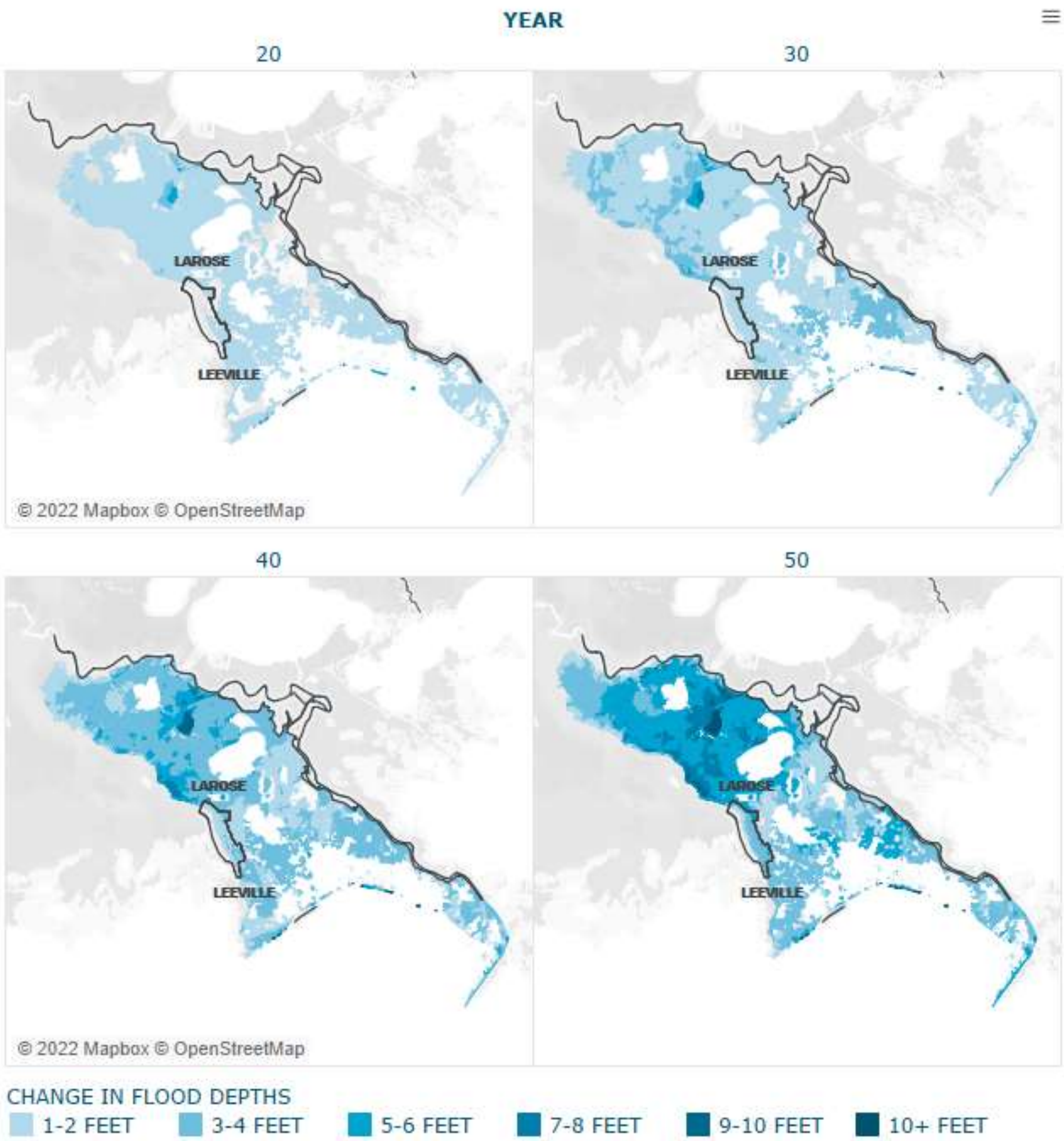

Figure 90. Change in 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

DISCUSSION

Hazard estimates for the Barataria region show increases in both the extent and depth of flooding over the period of analysis. These increases are generally linear in both lower and higher scenarios. The greatest increase in depths over time, across a range of return periods, occurs in the Des Allemands area, which sees a sudden increase over the first 20 years, particularly at more frequent return periods like the 1 in 10-year flood depths. This increase is likely due to an inability of the Grand Bayou Canal levee to continue blocking surge from entering the community.

The spatial pattern of areas with highest projected flood depths is consistent over time and in both scenarios. In the lower basin, the Larose to Golden Meadow and lower Plaquemines levees induce noticeable surge pileup in their vicinity, resulting in depths higher than other parts of the lower basin. The most notable change in hazard over time is a steady expansion of floodplains in the upper basin, particularly in the higher scenario. Increased mean sea levels, along with higher initial water levels in other water bodies like Lake Salvador, allow tropical cyclones to push surge further inland, with the 1% AEP floodplain nearly reaching Donaldsonville at the head of Bayou Lafourche. This expansion leads to substantial increases in hazard and projected damage in communities such as Chackbay, Luling, Paradis, and South Vacherie.

Because of the 2023 Coastal Master Plan's assumptions regarding levee maintenance and improvements to projects like the NOV system, protected polders in the Barataria Basin do not see as much of an increase in hazard (e.g., 10% and 1% AEP flood depths) over time. While the Larose to Golden Meadow Hurricane Protection Project is projected to lose its 1 in 100-year level of protection over time, the resulting flood depths in the Cut Off, Galliano, and Golden Meadow communities remain much lower than the surrounding area.

3.5 FLOOD DAMAGE PROJECTIONS

As noted previously, the Barataria region contains communities protected by levee systems along the Mississippi River in Plaquemines Parish (southeast of Greater New Orleans) and on its western boundary within the Larose to Golden Meadow Hurricane Protection Project. Some other communities are largely protected by their locations at higher elevation, along the Bayou Lafourche or the Mississippi River west of New Orleans, but others like Grand Isle, Port Fourchon, and Chackbay are exposed to frequent flooding.

LOWER SCENARIO

In the lower Barataria Basin south of Lake Salvador, communities outside of the enclosed protection systems are highly vulnerable, with the majority of structural assets exposed to inundation by a 2% AEP flood event (Figure 91). Overall, however, these unprotected lower Barataria communities represent a small percentage of the region's population, leaving the large majority in protected areas or at higher elevation in the upper basin.

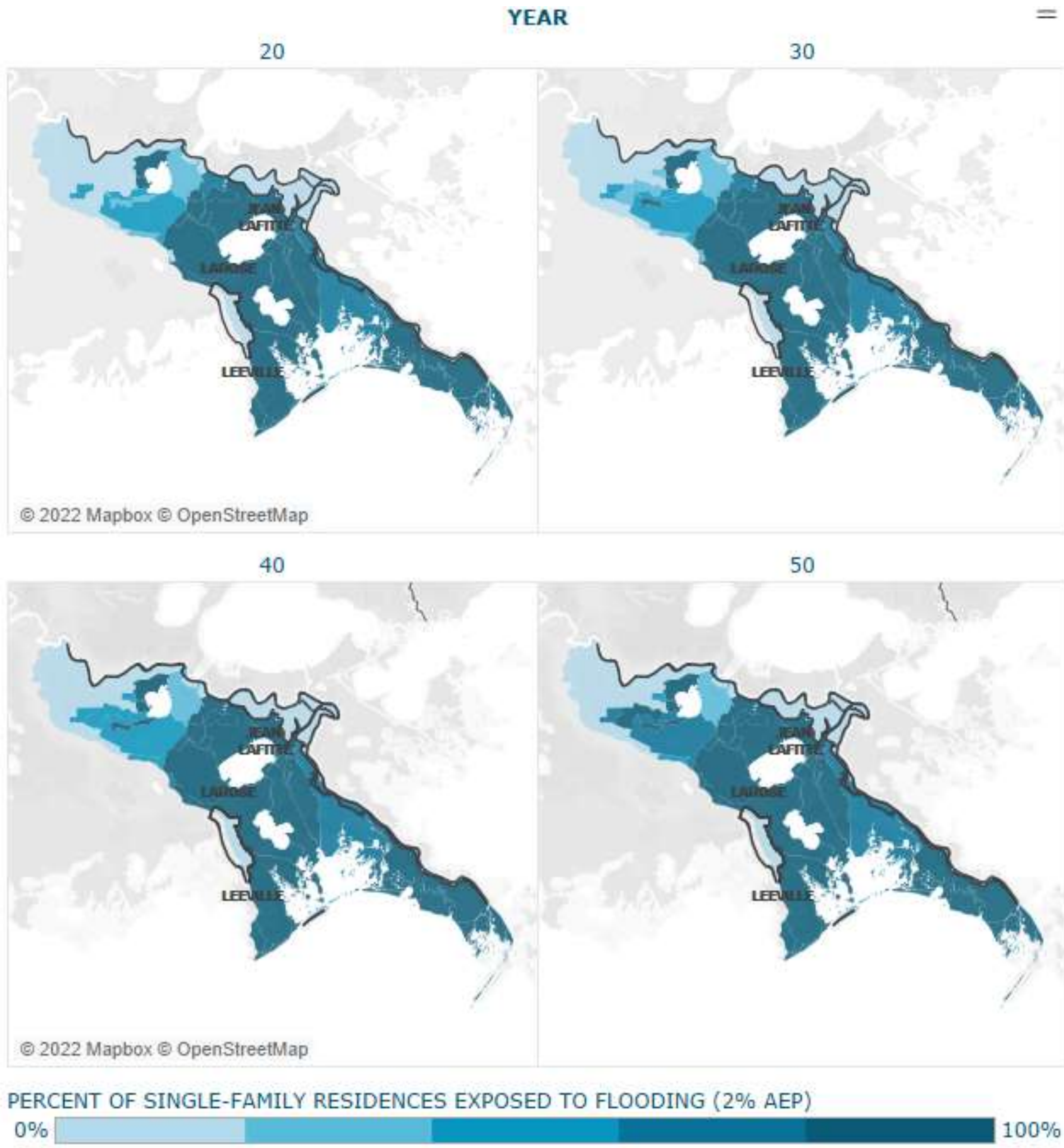

Figure 91. Residential structures exposed to 2% annual chance (1 in-50 year) flood depths above first floor elevation in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

This results in 55% of single-family residential structures not being exposed to inundation from a 2% AEP flood event in the Year 0 initial conditions scenario, and this value only declines to 50% by Year 50 (2070) in the lower scenario (Figure 92). Other types of structures are less frequently on elevated foundations, so a greater proportion of multi-family and non-residential structures face exposure from a similar event.

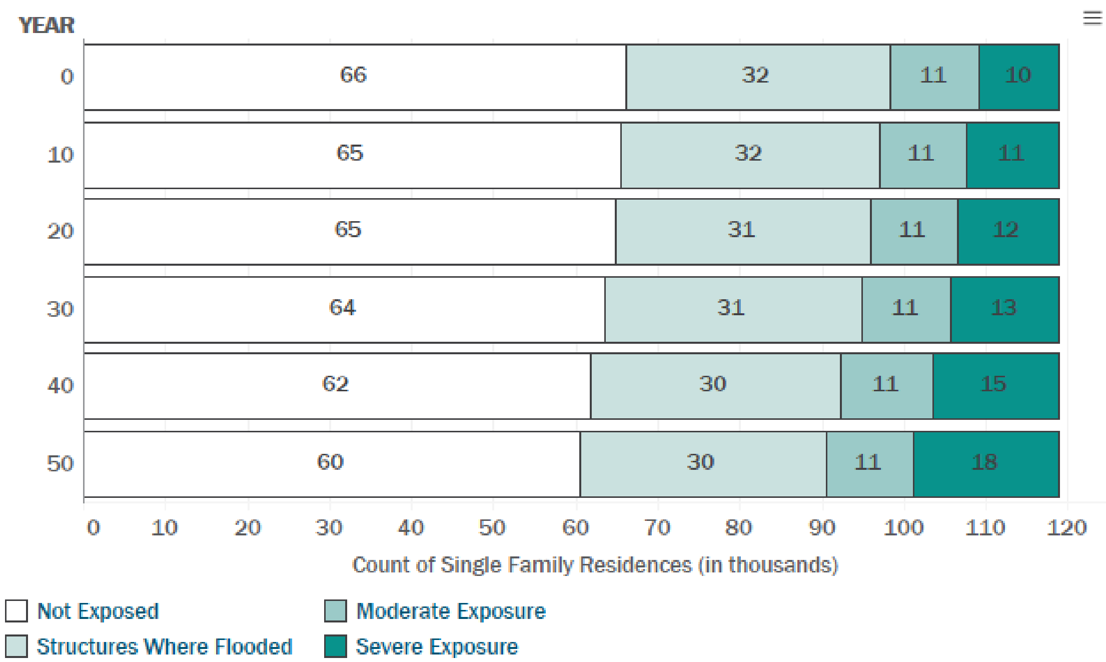

Figure 92. Residential structures exposed to 2% annual chance (1 in 50-year) flooding by exposure category in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile. Note: existing residences only, not accounting for population change.

About half as many residential structures are located in areas that do experience flooding from a 1 in 50-year event, though their first-floor elevations are above the associated flood depths. This pattern remains consistent over time. In all years modeled, about 9% of single-family residences are moderately exposed to such an event (i.e., non-zero inundation less than 2 feet above the first-floor elevation).

The exposure of some communities does increase more substantially from 2020 to 2070. The area within the Larose to Golden Meadow Hurricane Protection Project sees a 66% increase in the number of single-family residences moderately exposed to a 1 in 50-year event. This corresponds to the system no longer providing its currently certified 1% AEP protection, but even with this increase, the total number of such homes with moderate exposure represents only about 10% of those located within the protection system.

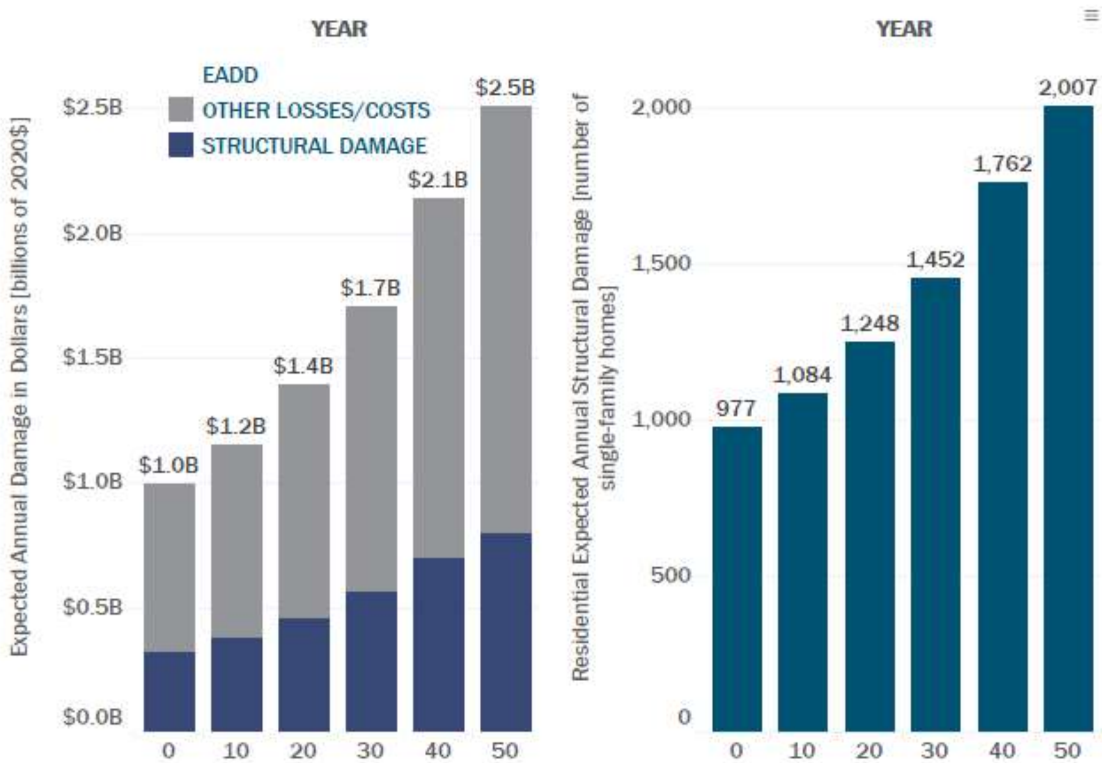

Figure 93. EADD (left) and residential EASD (right) in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

When summarizing economic risk over the entire distribution of potential inundation, the Barataria region comprises approximately $1 billion in EADD under initial conditions in 2020 (Figure 93). This more than doubles to $2.5 billion by Year 50, with the largest decadal increases coming in later years from 2050 to 2060 and 2060 to 2070. This accelerating pattern is replicated in the EASD metric describing the vulnerability of single-family residences, where the decade over decade increase from 2060 to 2070 approximately doubles the increase from 2020 to 2030. Consistent with other regions and scenarios, damage to physical structures only represents about one-third of expected direct economic damage, with the remainder accruing to contents and inventory or generated by lost rents, sales, etc., or damage to nonstructural assets like vehicles.

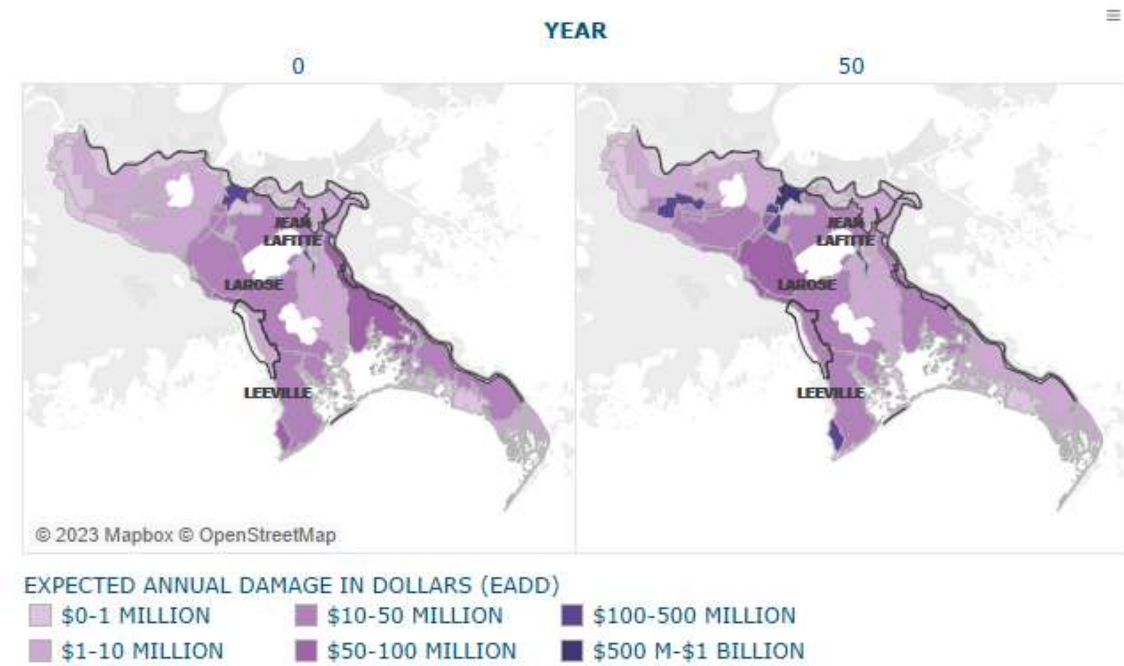

Figure 94. EADD by community in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

In 2020, the largest concentrations of expected annual damage in the region are in Luling, along the Mississippi River, and on Grand Isle. By 2070, other communities like Chackbay, Paradis, and Des Allemands experience substantially greater economic risk as the floodplain expands further up-basin, producing greater inundation at more frequent return periods (Figure 94).

The change in economic risk over time, despite the flood hazard increasing substantially with an expanding floodplain, is conflated by projected changes in population and assets. This is particularly noticeable in unprotected parts of the lower basin, where EADD declines over time (Figure 95). The same holds true in the protected lower Plaquemines communities, but substantial increases are seen in the Upper Barataria communities previously noted.

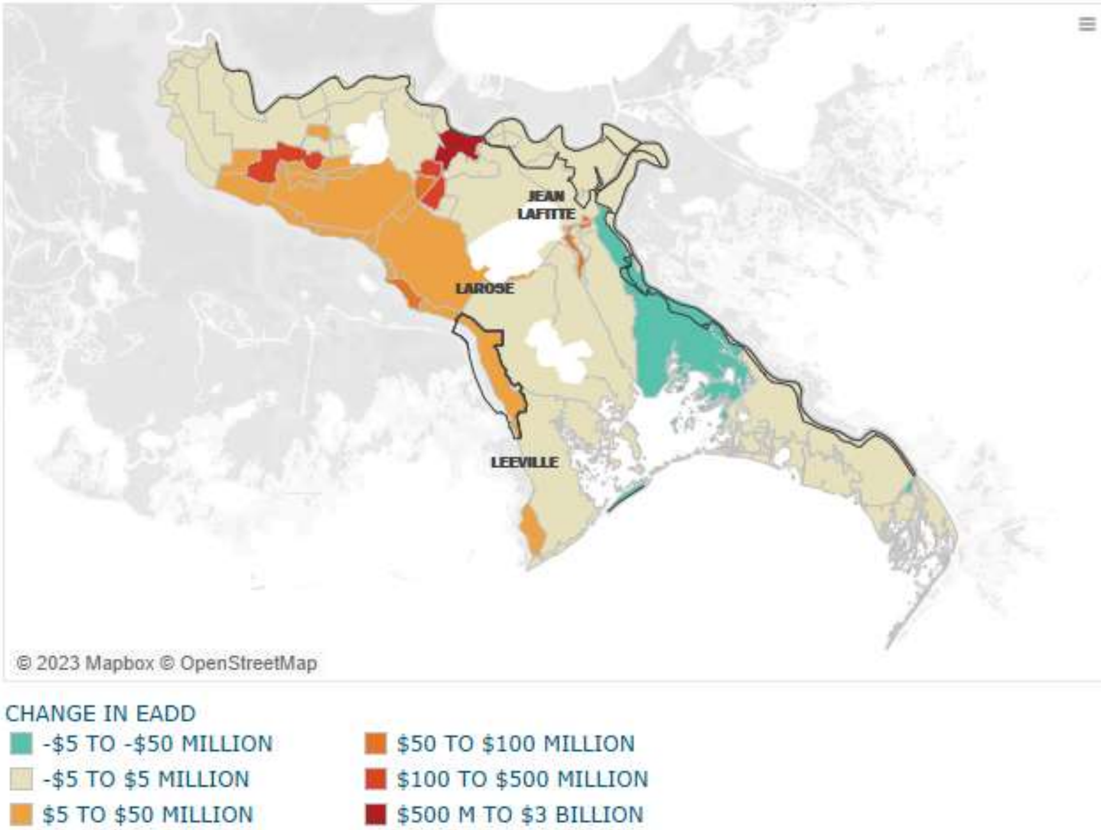

Figure 95. Change in expected annual damage by community in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile, Year 50 – Year 0.

EADD in Luling and Chackbay both show large increases over time, but they exhibit different patterns in the decades between 2020 and 2070 (Figure 96). Luling's EADD increases at a relatively constant rate over the 50-year period. Chackbay sees only $2 million in EADD under initial conditions, and its economic risk only starts to increase dramatically between years 30 and 40, eventually reaching $179 million at the end of the planning horizon.

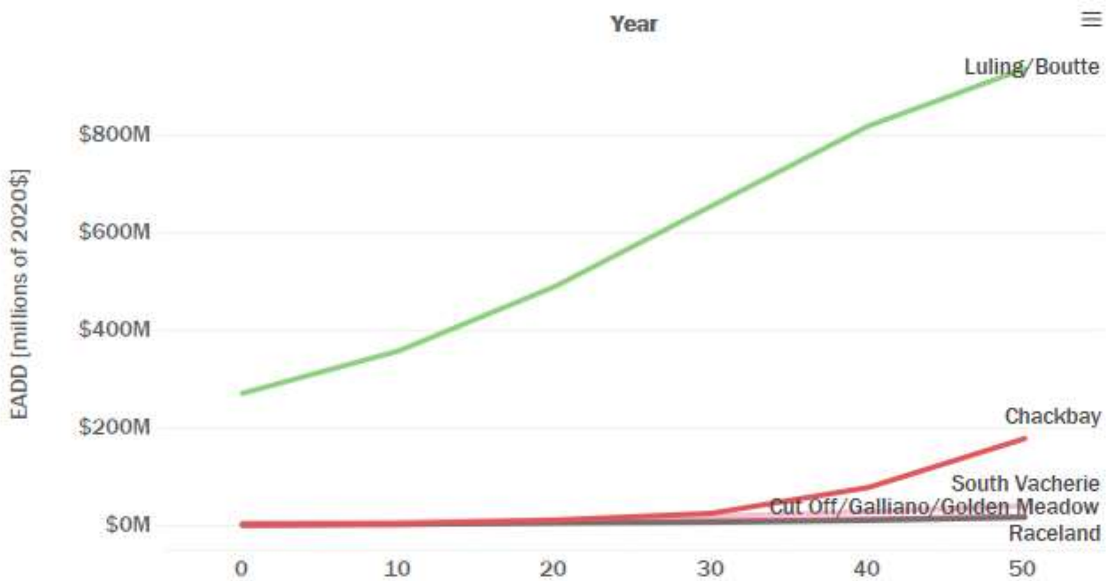

Figure 96. EADD in selected Barataria communities over the 50-year simulation period in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

HIGHER SCENARIO

In future years of the higher scenario, the set of communities extends much further up-basin in which a majority of structural assets are exposed to inundation by a 2% AEP flood event (Figure 97). The spatial pattern of exposure and damage is fairly similar to that in the lower scenario, but increased levels of exposure occur in earlier decades and the percentage of assets with moderate to severe exposure in Year 50 is substantially greater (Figure 98).

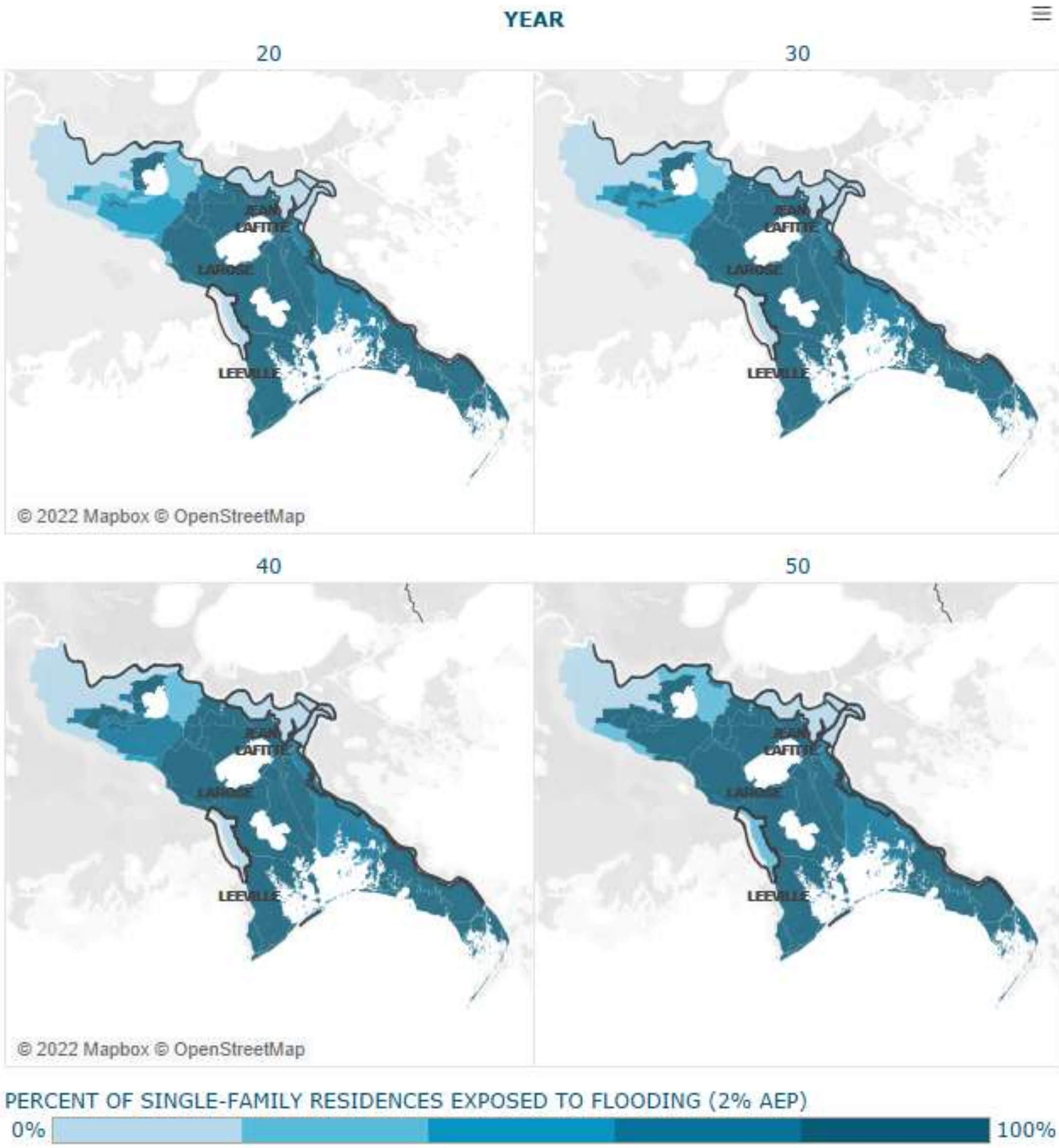

Figure 97. Residential structures exposed to 2% annual chance (1 in 50-year) flood depths above first floor elevation in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Specifically, in Year 50, the residential structures not exposed to a 2% AEP event are reduced by 4% compared to the lower scenario. The number facing severe exposure increases by 4% of such assets. The percentage in inundated areas or facing moderate exposure are unchanged, although they are not necessarily the same structures; this reflects a general shift of about 4% moving up from one exposure category to the next more extreme.

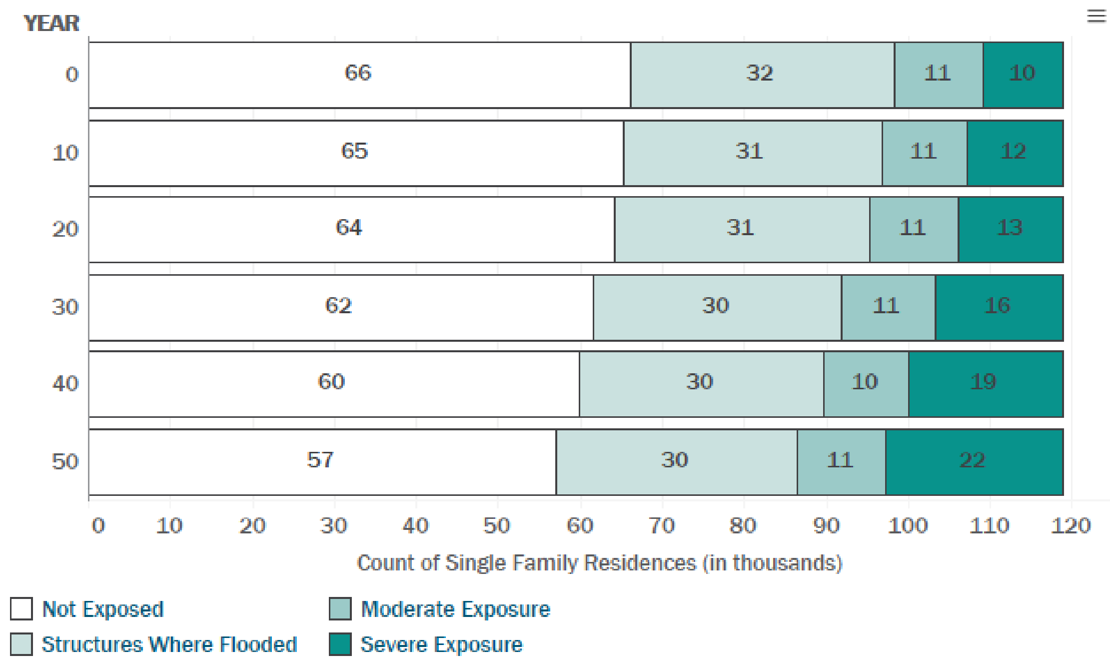

Figure 98. Residential structures exposed to 2% annual chance (1 in 50-year) flooding by exposure category in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

EADD and EASD both increase more rapidly in the higher scenario, with values in Year 50 approximately 35% and 40% greater, respectively, than in the lower scenario (Figure 99). Consistent with other regions and scenarios, damage to physical structures only represents about one-third of expected direct economic damage, with the remainder accruing to contents and inventory or generated by lost rents, sales, etc., or damage to nonstructural assets like vehicles.

The spatial distribution of risk in the higher scenario is also very similar to the lower scenario (**Error! Reference source not found.**), due to the similarity in inundation patterns combined with the assumption that future population change does not respond to differences in flood hazard. As a result, similar patterns can be seen, where some unprotected communities experience similar projections of economic damage over time, or even a reduction (Figure 101), due to a balance of increasing hazard but decreasing assets.

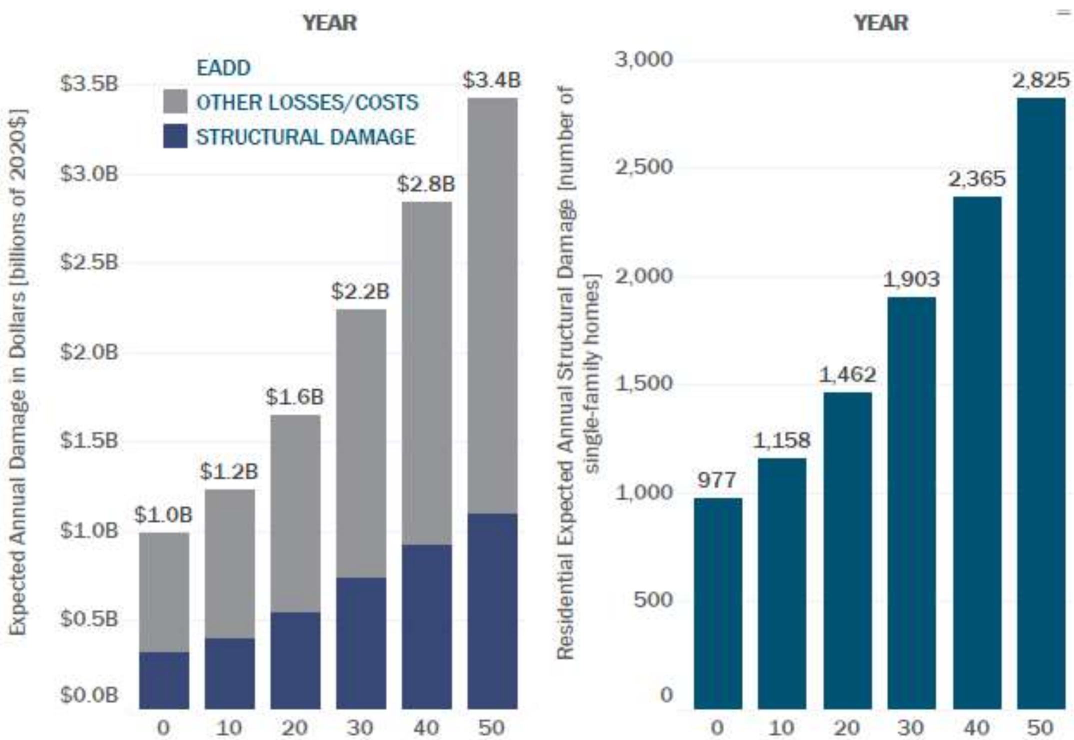

Figure 99. EADD (left) and residential EASD (right) in a higher scenario — IPET fragility, 50% pumping scenario, 50^{th} percentile.

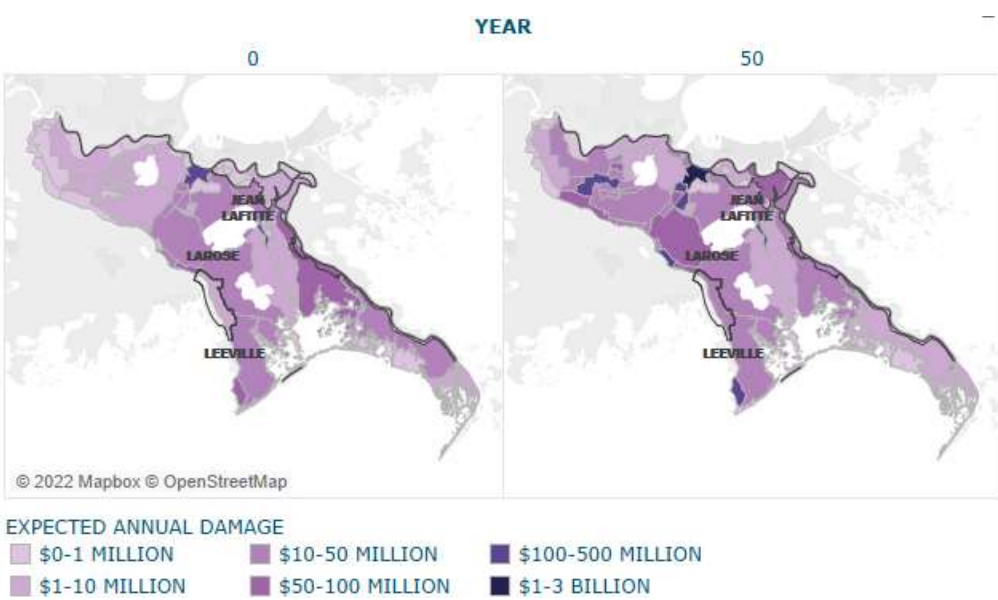

Figure 100. EADD by community in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

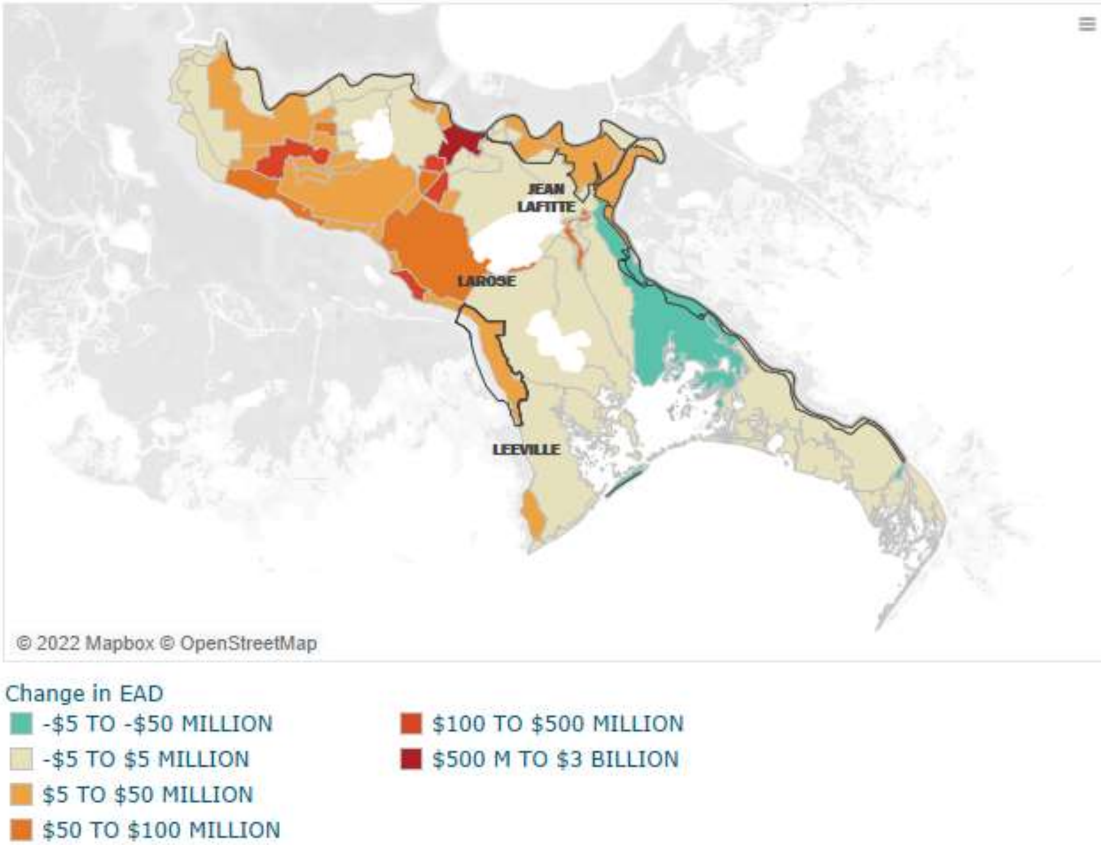

Figure 101. Change in expected annual damage by community in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile, Year 50 – Year 0.

In the higher scenario, EADD in Luling follows a similar pattern, a steady increase decade over decade, as in the lower scenario (Figure 102), although the end point is higher: $1,171 million instead of $936 million. The pattern in Chackbay also resembles that of the lower scenario, though in the higher scenario, its EADD begins to notably accelerate a decade earlier, now between years 20 and 30.

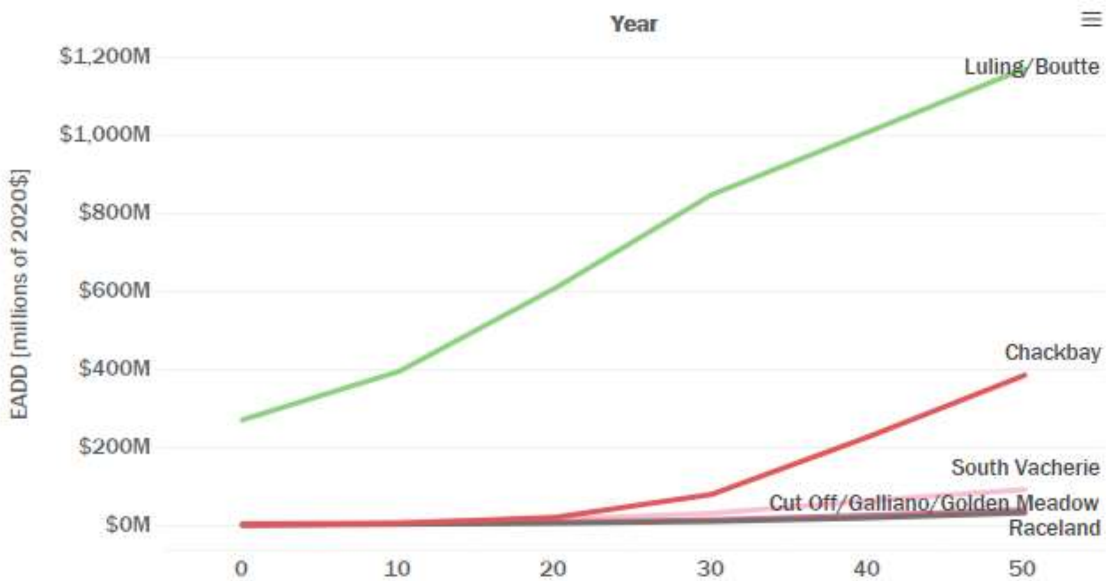

Figure 102. EADD in selected Barataria communities over the 50-year simulation period in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

DISCUSSION

Projected economic damage in the Barataria region increases more quickly in the higher scenario than the lower, as expected. For unprotected communities that already have substantial exposure under initial conditions, this manifests as 30 to 40% greater EADD and EASD values in the higher scenario for a given time period. In the protected polders along the Mississippi River and in the Larose to Golden Meadow Hurricane Protection Project, increases in risk over time are more abrupt, corresponding to periods when rising sea levels and land subsidence in front of the protection systems yield sudden jumps in the likelihood of surge and wave overtopping into the interiors.

This results in some of the largest proportional increases in damage from 2020 to 2070; the EADD in Cut Off/Galliano/Golden Meadow jumps by an order of magnitude over the 50-year period, but this is attributable to the low initial baseline behind a federally accredited levee that provides protection from greater than 1 in 100-year storm surge events. Despite not having such a protection system, other communities along Bayou Lafourche and further up-basin exhibit even greater proportional increases, such as Raceland's EADD increasing from $40M to $626M over 50 years in the higher scenario.[5] This also occurs in communities with notable increases in hazard, like Chackbay, Luling, Lockport, and South Vacherie.

[5] Note that the community of Raceland straddles two different regions; EADD from only the portion of Raceland located in Barataria is shown in Figure 96 and Figure 102.

4.0 TERREBONNE

4.1 DESCRIPTION

GEOGRAPHY

The Terrebonne region is bordered on the east by Bayou Lafourche, from Donaldsonville in the north to Port Fourchon in the south. On the west, the region is bounded by Bayou Shaffer and the bank of the Lower Atchafalaya River south of Morgan City to its mouth, then following the shoreline around Atchafalaya Bay to Point Au Fer. An abandoned delta complex, the Terrebonne region is dominated by cypress swamp and coastal wetlands bisected by several former distributary ridges. The highest land elevation in the region is located atop these ridges, the majority of which extend southward from the city of Houma.

The upper expanse of the Terrebonne region includes portions of Terrebonne, Lafourche, Assumption, St. Martin, St. Mary, Iberville, and Ascension parishes, while the lower reach includes portions of Lafourche, St. Mary, and Terrebonne parishes. Most of the development in the northern portion of the region includes a combination of suburban and rural/agricultural development (Figure 103). Due to their high elevation relative to the surrounding landscape, the natural levees along the region's rivers and bayous have historically served as the site of human settlement in the region. In contrast, the lower portion of the region includes a combination of urban, suburban, and rural/agricultural development that transitions to a system primarily consisting of tidally influenced marshes connected to a series of wide, shallow lakes and bays, beyond which are found several chains of barrier islands.

Throughout the region, most of the development is centered on the natural levees and ridges. This includes the communities located along Bayou Lafourche, from Port Fourchon on the Gulf to its junction with the Mississippi River in Donaldsonville. Urban development in the region is centered on Houma, which is crossed by several primary waterways including the GIWW and bayous Terrebonne, Black, and LaCarpe. Houma is connected directly to the Gulf by the Houma Navigation Canal. Bayou Black and the GIWW also serve as east-west focal points of development in the region, effectively connecting the Mississippi River and Bayou Lafourche with the Atchafalaya River near the communities of Morgan City, Berwick, and Siracusaville.

Outside the fastlands, the Terrebonne region supports a range of swamp and marsh ecosystems. The majority of the region's cypress swamp habitat is located in the sub-basin that contains Lake Verret, a natural lake located in Assumption Parish to the west of Napoleonville and south of Pierre Part. Beyond the swamps around Lake Verret, the Terrebonne region supports extensive fresh marsh, including flotant marsh, which grades from intermediate to brackish and then to saline near the bays of the Gulf. Many of the wetlands in the region are currently stressed as a result of high-water levels. Marsh loss rates in the region are high due to a combination of sediment deficit, saltwater intrusion along the Houma Navigation Canal and other canals, historic oil and gas activity, and natural deterioration of the barrier islands, which contributes to increased erosion, scour, and saltwater intrusion of the marshes, with several locations converting to open water.

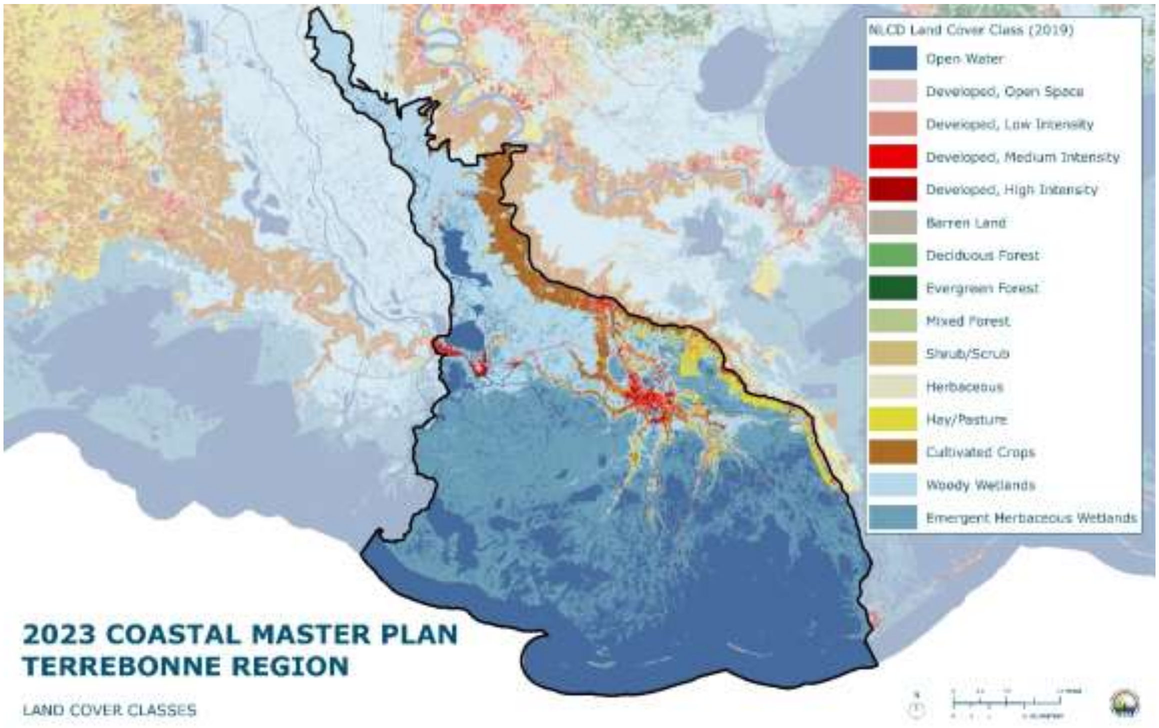

Figure 103. Land cover types in the Terrebonne region.

STRUCTURAL PROTECTION

The natural elevation of the distributary ridges of the region provides limited protection from coastal hazards for the communities located along them. The proximity of many of these communities to the Gulf make them especially vulnerable to storm surge and other tropical weather hazards, many of which are powerful enough to overtop the natural levees. Currently, the Terrebonne region has limited structural protection on the eastern and western boundaries (Figure 103). This includes the Southern East Atchafalaya River Levee on the west and the Larose to Golden Meadow Hurricane Protection Project, a ring levee approximately 48 miles in length protecting communities along the east and west banks of Bayou Lafourche from the GIWW at Larose to just south of Golden Meadow. Bayou Lafourche is the dividing line between the Terrebonne and Barataria regions, with the west bank of the bayou located in the Terrebonne region. Designed to provide a 100-year level of hurricane protection, the Larose to Golden Meadow Hurricane Protection Project also provides for the construction of navigable floodgates on Bayou Lafourche at the upper and lower limits of the project area.

Current structural protection features leave the majority of the Terrebonne region largely unprotected from hurricane storm surge, including the city of Houma and the communities that comprise the Houma-Thibodaux metropolitan statistical area, a densely populated region with over 207,000 residents. The area has been affected by a deterioration of its coastal marshes as a result of saltwater intrusion, land subsidence, and the lack of sediment deposits from the Mississippi River and its tributaries. According to USACE, this deterioration has led to increased hurricane and storm surge inundation (USACE, 2013).

To provide additional protection to the residents of the Terrebonne region, state and federal agencies have authorized and began construction on the Morganza to the Gulf project, a 98-mile alignment consisting of grass-covered earthen levees, 22 floodgates on navigable waterways, 23 environmental water control structures, nine road gates, and fronting protection for four existing pump stations. Morganza to the Gulf aims to provide risk reduction for people and property in the vicinity of Houma, as well as protecting the remaining marsh in the region from hurricane storm surge. This levee system will stretch from U.S. Highway 90 near the town of Gibson to the west and Louisiana Highway 1 near Lockport to the east, enclosing Houma and many of the bayou communities located on the distributary ridges, including Dulac, Dularge, Chauvin, and Montegut. Several smaller communities located on the distributary ridges as they transition closer to the Gulf, such as Cocodrie and Isle de Jean Charles, remain outside the structural protection provided by Morganza to the Gulf.

Figure 104. Structural protection in the Terrebonne region.

POPULATION

The Terrebonne region includes all of Terrebonne Parish, and parts of Lafourche, Assumption, St. Martin, St. Mary, Iberville, and Ascension parishes. The population of the region, as with many of the communities located across Louisiana's coastal zone, is concentrated on the limited high ground interspersed throughout the coastal marsh and swamps. Many of these communities are located along the eastern boundary of the region, along Bayou Lafourche, within the Larose to Golden Meadow Hurricane Protection Project below the GIWW and outside structurally protected areas north of the waterway. On the western edge of the region, the communities of Morgan City, Berwick, Siracusaville are located on the GIWW at its intersection with the Atchafalaya River. This grouping of communities ranges from the Terrebonne region into the Central Coast.

The Terrebonne region is bisected by the GIWW. This federal navigation channel has a controlling depth of 12 feet and has been designed primarily for barge transportation. It also serves to effectively delineate the coastal marshes from the more heavily developed northern portion of the region that comprises the densely populated Houma-Thibodaux metropolitan statistical area.

LOWER TERREBONNE BASIN — THE HOUMA-THIBODAUX METROPOLITAN STATISTICAL AREA AND BAYOU COMMUNITIES

The lower portion of the Terrebonne Basin includes portions of several parishes, including Lafourche and St. Mary, although the majority of this area, including the city of Houma and the bayou communities located to the south, are located in Terrebonne Parish (Figure 105). Houma is the parish seat of government and is located on the GIWW. The city is directly connected to the Gulf by the Houma Navigation Channel, a 36.6-mile navigation channel for commercial vessels constructed in 1962 by the Terrebonne Parish Government. The channel provides a direct water route between the Gulf and the Port of Terrebonne, located in Houma along the GIWW. Expansion of Houma Navigation Canal and its system of locks is a critical element of the Morganza to the Gulf project.

Houma is the principal trade center for the region and is home to a number of sugarcane and seafood processing plants, offshore oil production services industries, and boat repair facilities. It is bisected by U.S. Highway 90, a principal transportation route for southeast Louisiana. A number of bayous originate in Houma and stretch southward to the lakes, bays, and coastal marshes of the region, including Bayou Grand Caillou and Bayou Chauvin. The natural levees of these bayous are home to a number of small communities that are heavily dependent on the renewable and nonrenewable resources of the coastal zone, including oil and gas production and commercial fishing. Primary commercial fisheries in the region include shrimp, menhaden, oysters, crabs, and finfish.

Unlike Bayou Grand Caillou and Bayou Chauvin, Bayou Black stretches westward, connecting the Houma-Thibodaux metropolitan statistical area with the Morgan City metropolitan statistical area and the Atchafalaya Basin. Morgan City is heavily dependent on two key industries, oil and gas production and commercial shrimping. Morgan City is home to the Port of Morgan City with a number of docking and cargo handling facilities that allow shippers moving shallow and medium draft vessels in the Gulf.

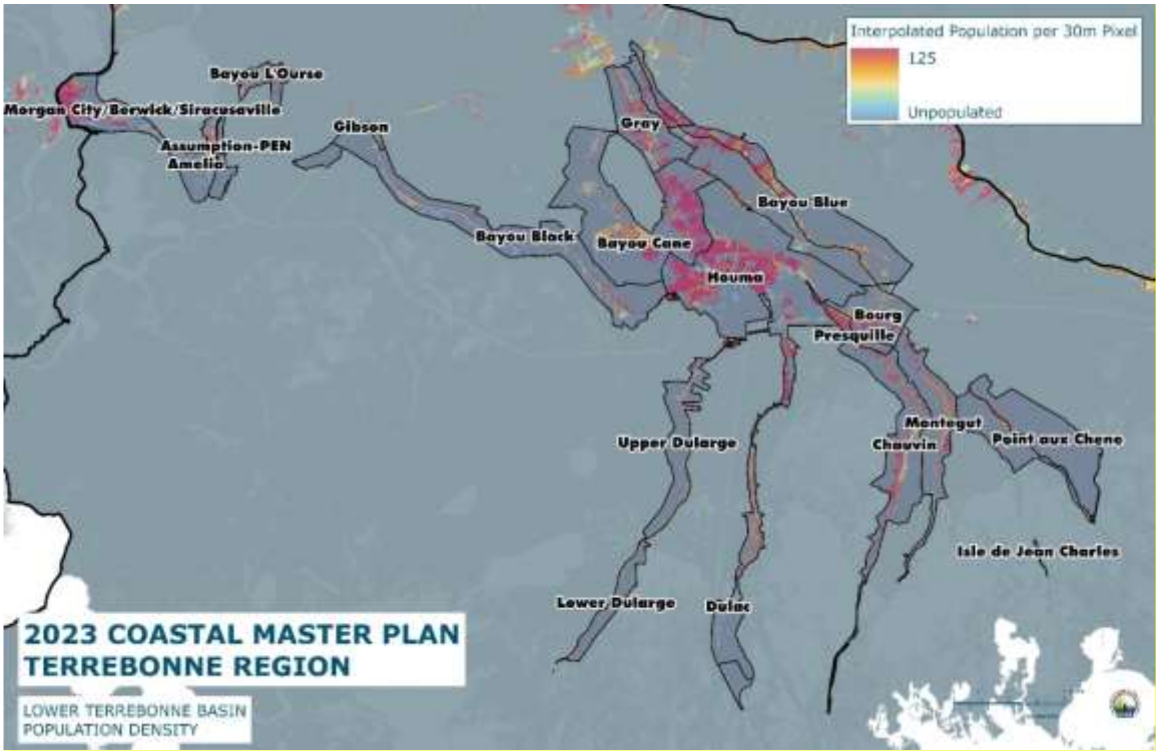

Figure 105. Population density of the Houma-Thibodaux metropolitan statistical area and communities in the Lower Terrebonne Basin.

The urbanized core of the Houma-Thibodaux metropolitan statistical area is Houma, a city of nearly 42,000 residents. The city has slightly lower percentages of Black and Asian residents than the overall state averages of 33 and 1.9%, respectively (Table 9). Of the communities located in the lower Terrebonne Basin, only Gibson and Gray have percentages of Black residents that exceed the statewide average.

However, the percentage of Indigenous residents in Houma is 5.3%, significantly higher than the state average of 0.8%. Lafourche and Terrebonne Parishes are home to the majority of the state's Indigenous residents, who have resided along the region's bayou and in the marshes for generations. This includes the United Houma Nation, the largest state-recognized tribe in Louisiana. Other smaller Indigenous tribal bands, including the Bayou Lafourche Biloxi Chitimacha, the Pointe-au-Chien Indian Tribe, the Isle de Jean Charles Biloxi-Chitimacha-Choctaw, and the Grand Caillou/ Dulac Biloxi-Chitimacha-Choctaw, reside throughout the region. All of the communities that comprise the lower Terrebonne Basin have proportions of Indigenous residents that exceed the statewide average.

Table 9. Demographics of the Houma-Thibodaux metropolitan statistical area and communities in the Lower Terrebonne Basin

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
AMELIA	2,196	707	177	58	253	1,056	514
		32.2%	**8.1%**	**2.6%**	**11.5%**	**48.1%**	**21.7%**
BAYOU BLACK	3,324	1,923	1,069	89	20	136	491
		57.9%	**32.2%**	**2.7%**	**0.6%**	**4.1%**	**11.2%**
BAYOU BLUE	17,436	12,902	1,443	861	73	1,644	4,689
		74.0%	**8.3%**	**4.9%**	**0.4%**	**9.4%**	**19.9%**
BAYOU CANE	24,826	17,434	3,889	822	386	1,531	4,263
		70.2%	**15.7%**	**3.3%**	**1.6%**	**6.2%**	**16.2%**
BAYOU L'OURSE	1,806	1,450	55	38	21	202	643
		80.3%	**3.0%**	**2.1%**	**1.2%**	**11.2%**	**30.5%**
BOURG	2,468	2,139	20	111	5	84	124
		86.7%	**0.8%**	**4.5%**	**0.2%**	**3.4%**	**4.8%**
CHAUVIN	5,631	4,659	361	248	28	151	901
		82.7%	**6.4%**	**4.4%**	**0.5%**	**2.7%**	**12.0%**
DULAC	1,886	885	130	602	35	137	748
		46.9%	**6.9%**	**31.9%**	**1.9%**	**7.3%**	**47.5%**
DULARGE - LOWER	538	395	9	87	0	18	136
		73.4%	**1.7%**	**16.2%**	**0.0%**	**3.3%**	**26.7%**
DULARGE - UPPER	1,115	915	45	73	6	32	190
		82.1%	**4.0%**	**6.5%**	**0.5%**	**2.9%**	**8.9%**
GIBSON	374	190	135	15	1	10	77
		50.8%	**36.1%**	**4.0%**	**0.3%**	**2.7%**	**20.3%**
GRAY	5,507	2,792	2,055	160	47	244	1,198
		50.7%	**37.3%**	**2.9%**	**0.9%**	**4.4%**	**18.4%**
HOUMA	41,925	23,760	10,426	2,235	695	3,499	8,917
		56.7%	**24.9%**	**5.3%**	**1.7%**	**8.3%**	**22.2%**
ISLE DE JEAN CHARLES	41	6	0	31	0	2	10
		14.6%	**0.0%**	**75.6%**	**0.0%**	**4.9%**	**21.7%**
MONTEGUT	3,215	2,274	90	445	18	151	823
		70.7%	**2.8%**	**13.8%**	**0.6%**	**4.7%**	**24.7%**
MORGAN CITY / BERWICK / SIRACUSAVILLE	21,270	14,107	3,718	238	245	2,416	7,792
		66.3%	**17.5%**	**1.1%**	**1.2%**	**11.4%**	**21.1%**
POINT AUX CHENE	1,820	1,002	6	702	3	16	543
		55.1%	**0.3%**	**38.6%**	**0.2%**	**0.9%**	**12.6%**
PRESQUILLE	2,227	2,004	44	66	9	47	152
		90.0%	**2.0%**	**3.0%**	**0.4%**	**2.1%**	**6.4%**

UPPER TERREBONNE BASIN

The upper expanse of the Terrebonne region includes portions of several parishes, including Terrebonne, Lafourche, Assumption, St. Martin, St. Mary, Iberville, and Ascension (Figure 106). Most of the development in the northern portion of the region is found in the fastlands and incudes a combination of suburban and rural/agricultural development. There are three incorporated cities in the northern portion of the Terrebonne region: Thibodaux, Napoleonville, and Donaldsonville. Thibodaux serves as the parish seat of Lafourche Parish while Napoleonville serves as the seat of Assumption Parish government. Donaldsonville, located at the junction of Bayou Lafourche and the Mississippi River, is the parish seat of Ascension Parish. Each of these communities straddle Bayou Lafourche and have population within both the Terrebonne Region and the Barataria region. Beyond these cities, the region is primarily agricultural and focused on sugarcane. Other important crops of the region include soybeans, corn, and livestock.

The U.S. Census Bureau considers Napoleonville to be part of the Pierre Part micropolitan statistical area with incudes Pierre Part, a census designated place located just east of the Atchafalaya Floodway and north of Lake Verret along the Avoca Island Cutoff. Pierre Part is a local center for fishing and crawfishing. The economy is also supported by tourism and swamp tours.

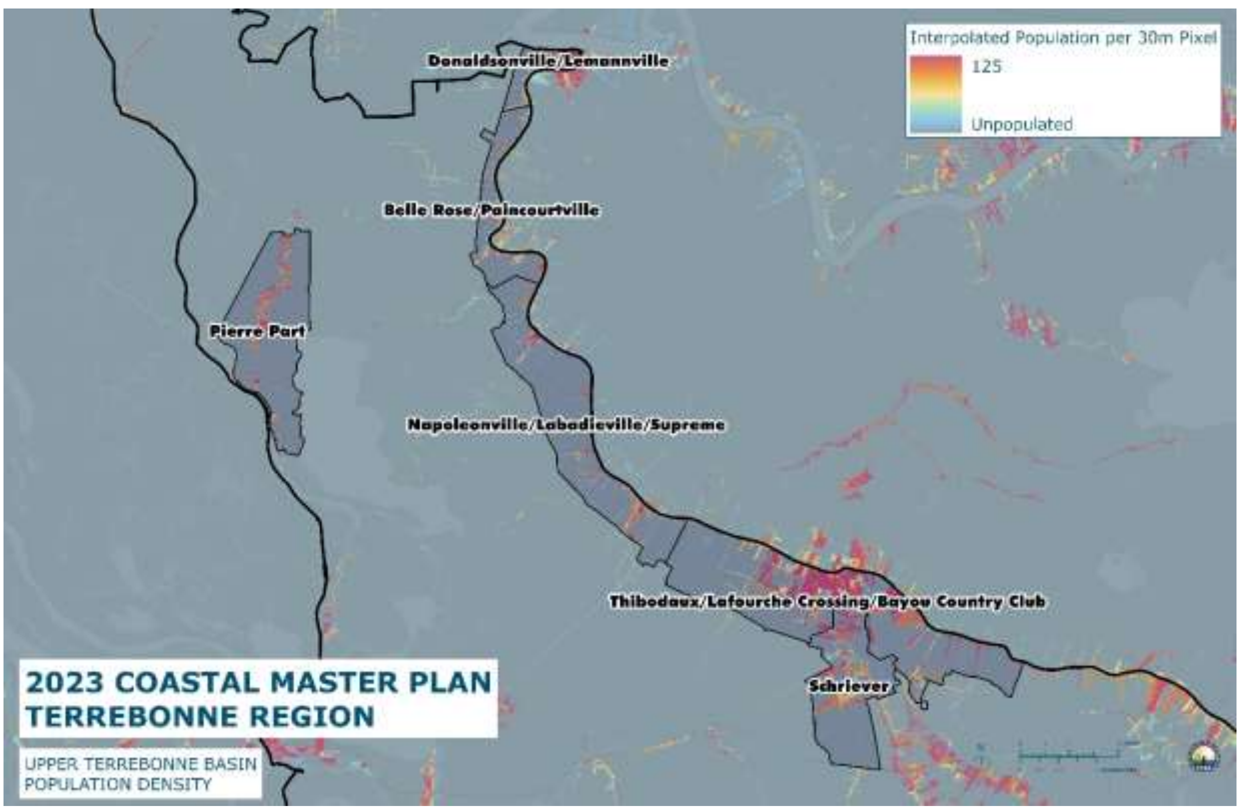

Figure 106. Population density of communities in the Upper Terrebonne Basin.

As seen in the lower portion of the Terrebonne Basin, the communities of the northern basin tend to have low percentages of minority residents (Table 10). The exceptions are the parish seats of Donaldsonville and Napoleonville and the Belle Rose/Paincourtville communities that separate them. These communities have a proportion of Black residents well above the statewide average, with the percentages increasing to the northern end of Bayou Lafourche.

Unlike the lower portion with its marshes and wetland landscapes, the northern portion is much less reliant on commercial, recreational, and subsistence fishing and more reliant on agricultural development. As a result, the communities of the northern basin do not have large numbers of Indigenous residents, many of whom have historically relied upon the marshes to support their economy and their cultural heritage.

Table 10. Demographics of communities in the Upper Terrebonne Basin

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
BELLE ROSE/ PAINCOURTVILLE	5,029	2,017	2,822	8	8	118	1,215
		40.1%	**56.1%**	**0.2%**	**0.2%**	**2.3%**	**12.5%**
DONALDSONVILLE /LEMANNVILLE	8,682	2,049	6,269	4	14	240	4,092
		23.6%	**72.2%**	**0.0%**	**0.2%**	**2.8%**	**39.6%**
NAPOLEONVILLE/ LABADIEVILLE/ SUPREME	6,982	3,805	2,773	34	18	301	1,807
		54.5%	**39.7%**	**0.5%**	**0.3%**	**4.3%**	**21.8%**
PIERRE PART	4,677	4,486	9	8	11	128	666
		95.9%	**0.2%**	**0.2%**	**0.2%**	**2.7%**	**17.6%**
SCHRIEVER	6,716	4,090	1,856	133	40	399	1,195
		60.9%	**27.6%**	**2.0%**	**0.6%**	**5.9%**	**20.2%**
THIBODAUX/ LAFOURCHE CROSSING/ BAYOU COUNTRY CLUB	35,607	22,811	10,026	305	274	1,514	6,017
		64.1%	**28.2%**	**0.9%**	**0.8%**	**4.3%**	**15.9%**

4.2 SUMMARY OF RISK

This section summarizes the simulation modeling results projecting coastal flood risk and damage for the Terrebonne region over a 50-year period in a FWOA. This includes projected storm surge and wave heights, flood depths, exposure of single-family residences, and flood damage. Model results show that SLR will be the primary influence on future storm surge in the Terrebonne region. Even when accounting for land building in the areas around the Atchafalaya River and Wax Lake Outlet deltas, expected decreases in land elevation and increasing sea levels will allow storm surge to penetrate further inland. As a result, anticipated flood hazard and economic damages are projected to increase decade over decade across the region with the distribution of damage directly tied to population density. Storm 388 is used to describe impacts within the Terrebonne region. Storm 388 has a perpendicular track to the coast and makes landfall near the Wax Lake Outlet. Surge is pushed against the levees throughout Terrebonne Parish, including the Larose to Golden Meadow and Morganza to the Gulf levee systems.

STORM SURGE AND WAVES

The topographic elevations provided by the ICM for the final two decades of the period of analysis generally shows decreases in elevation except near the Atchafalaya River and Wax Lake Outlet deltas, which are expected to continue to build land throughout the study period. As a result of lower topographic elevations, the impacts of friction on wind and water are expected to generally decrease throughout the region, even with land building in the Atchafalaya Basin allowing storm surge to penetrate further inland. While ADCIRC results show that SLR is the primary influence on storm surge, several areas of the Terrebonne region show an increase in surge less than the SLR increment used in the models, particularly south of the Morganza to the Gulf levee system. This is largely due to the ability of storm surge to move further inland with decreasing friction and topographic values.

Storm surge results in the higher scenario are similar to the lower scenario, though the magnitude is greater due to the increased SLR value. The area south of the Morganza to the Gulf levee system is expected to continue to show a change in peak water surface elevation less than the increment of SLR in both Year 30 and Year 50. The inundated area extends most of the way through the upper portion of the region by Year 50. Changes in wave height are expected to correspond to increases in total water depth.

Surge within the Morganza to the Gulf system increases in excess of the SLR increment because as storm surge more easily penetrates inland, it is more able to wrap around the edges of the system in addition to overtopping from the front side of the system.

FLOOD DEPTH AND DAMAGE

CLARA simulations for the Terrebonne region show increases in the both the extent and depth of flooding over the 50-year period of analysis. Flood hazard is projected to increase decade over decade, with some areas currently benefiting from elevated features experiencing sudden non-linear growth in flood depth exceedances at multiple return periods. This temporal pattern is complicated by the presence of local protection features that are not federally accredited and lose their benefits over time with degradation and rising sea levels. The Terrebonne region is expected to see several of its levee systems lose their 100-year protection around 2070 in the lower scenario and 2060 in the higher scenario. This includes both the Larose to Golden Meadow Hurricane Protection Project and

Morgan City levee system. The impacts of this loss of protection is expected to be very different in each of these two locations. CLARA simulations show that the Cut Off/Galliano/Golden Meadow community will continue to experience much lower flood depths than the unprotected surrounding area after the Larose to Golden Meadow Hurricane Protection Project loses its 100-year protection. Morgan City, in contrast, is projected to experience similar flood depths as nearby unprotected areas such as Amelia as the Morgan City levee system loses its 100-year protection.

While flood risk levels are projected to increase in many locations where levee protection is reduced, flood risk is expected to drop in areas where land building is occurring. The land building in the deltas of the Atchafalaya River and Wax Lake Outlet is expected to continue over the period of analysis and, in many cases, this may result in reductions in flood depths by the end of the period of analysis. For example, CLARA results show that flood depths in locations to the southwest of the town of Dularge will peak around Year 30 and then decrease over the remaining 20 years of the planning horizon. Similarly, the parts of Terrebonne behind enclosed protection systems are projected to experience non-linear increases in flood depth exceedances at various return periods as the decades progress.

Under the lower and higher scenarios, the percentage of residential structure expected to experience severe flooding two feet or more above first-floor elevations is projected to nearly quadruple over the 50-year period of analysis. When aggregated across the entire Terrebonne region, increases in structural damage are highly correlated to economic damage. Both variables are expected to experience a sharp acceleration from Year 20 onwards (Figure 107). EADD is projected to increase from $1.2 billion in 2020 to $5.7 billion and $9.6 billion in 2070 in the lower and higher scenarios, respectively. More than half of the increase in risk occurs from 2050 to 2070.

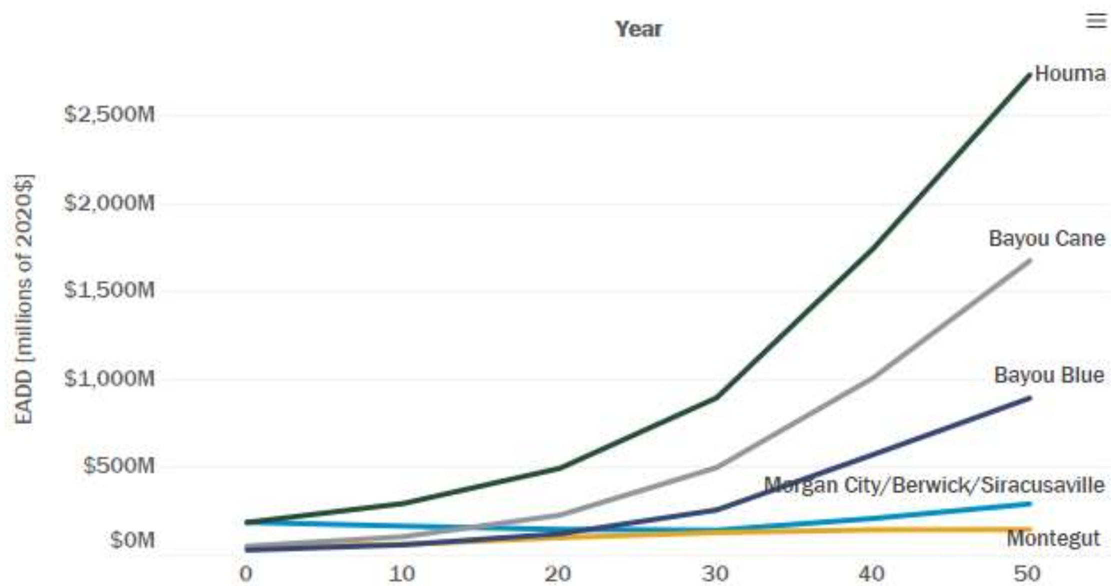

Figure 107. EADD in selected Terrebonne region communities over the 50-year simulation period under the higher scenario.

The distribution of economic damage is tied to the density of population and residential structures. Economic damage estimates are complicated due to expected population declines in many areas, particularly rural areas outside of federal levee protection. Population change in these already sparsely populated areas does little to stem the tide of increasing vulnerability when considering the Terrebonne region as a whole. The majority of risk and economic damage at the end of the planning period is concentrated in the densely populated areas around Houma and nearby communities such as Bayou Cane and Bayou Blue. In 2070 under the higher scenario, these communities collectively account for an estimated $5.3 billion in damages, more than half of the regional total of $9.6 billion.

4.3 STORM SURGE AND WAVES RESULTS

Topography and bathymetry are shown in Figure 108. Additionally, initial conditions land use was interpolated to the model to construct Manning's n (Figure 109), directional wind reduction (Figure 110), and surface canopy coefficients (Figure 111). Updated data is interpolated to the ADCIRC model from the ICM every 10 years. This section shows how the model changes in Year 30 and Year 50 and the associated simulation results.

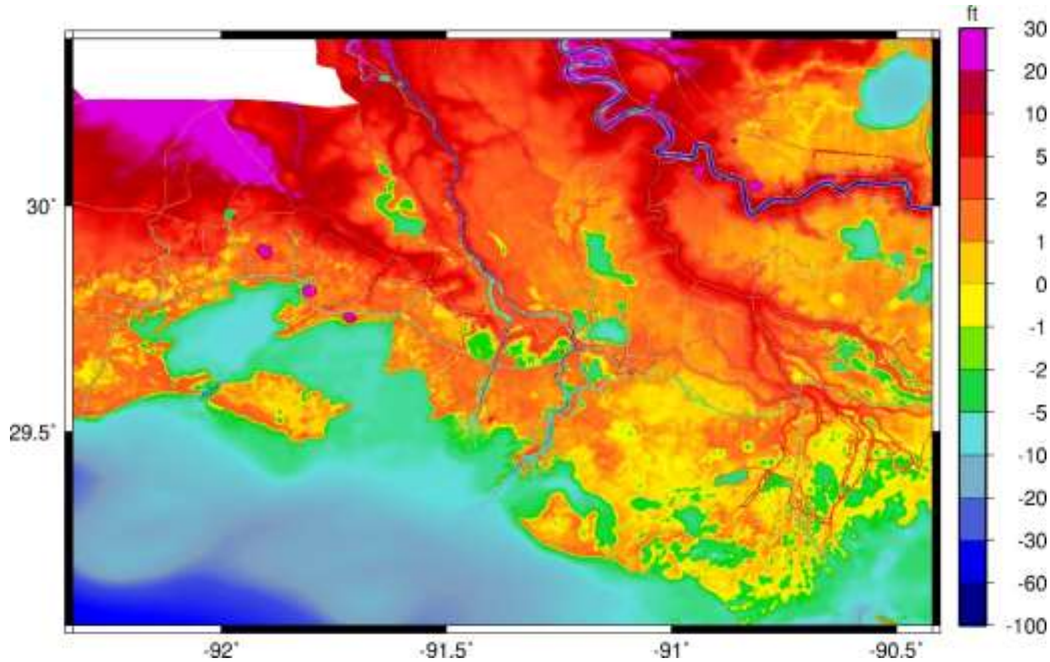

Figure 108. Topography and bathymetry (feet, NAVD88) in ADCIRC at Year 0.

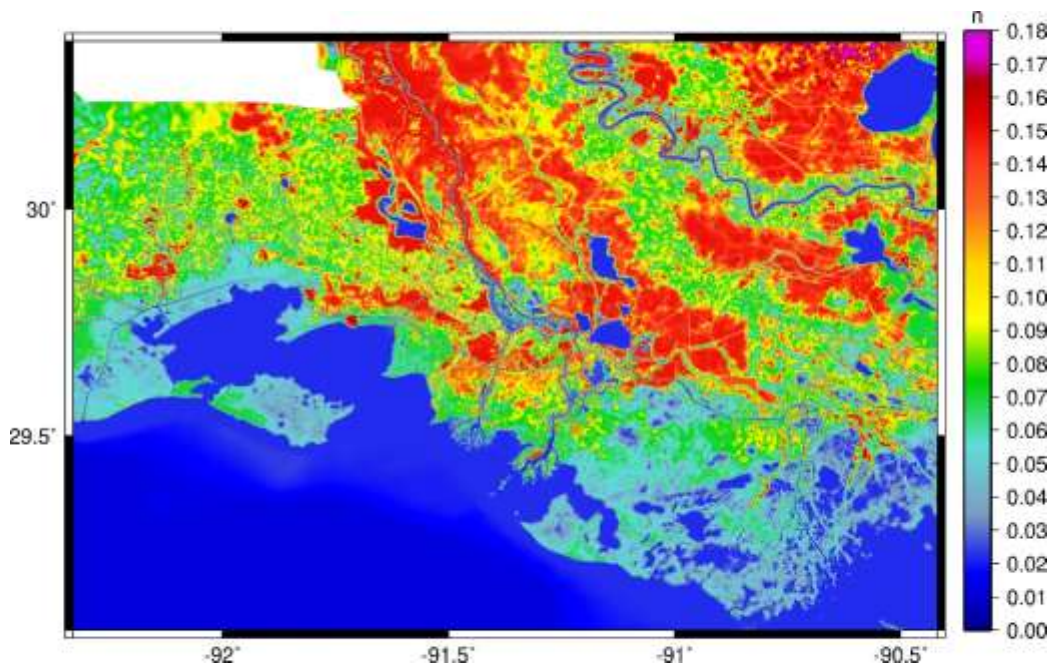

Figure 109. Manning's n coefficient in ADCIRC at Year 0.

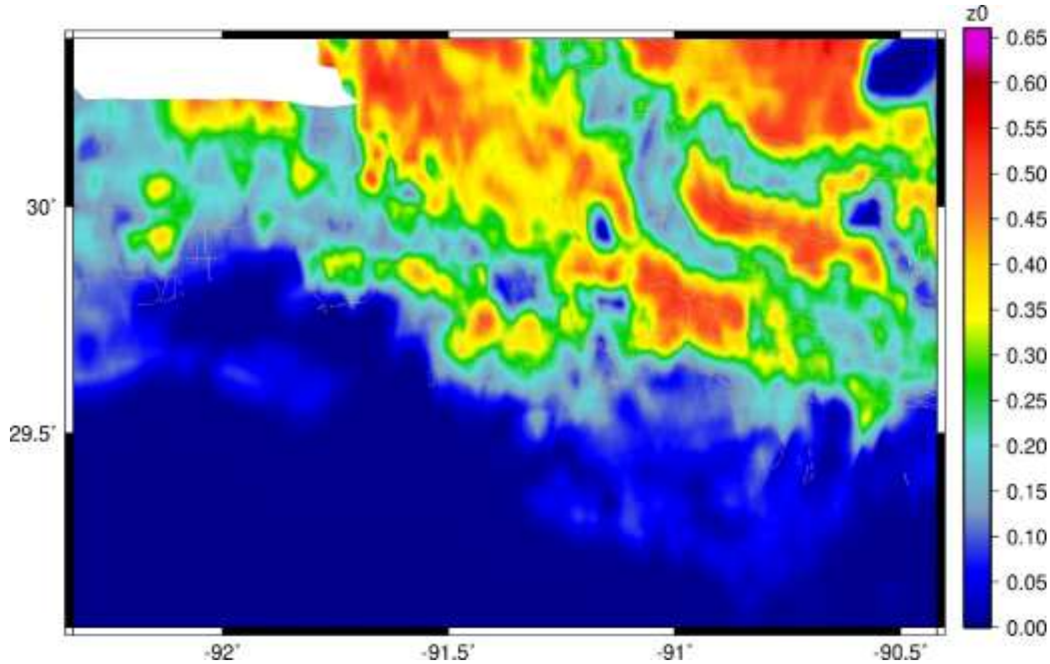

Figure 110. Directional wind reduction coefficient for a wind blowing from the south in ADCIRC at Year 0.

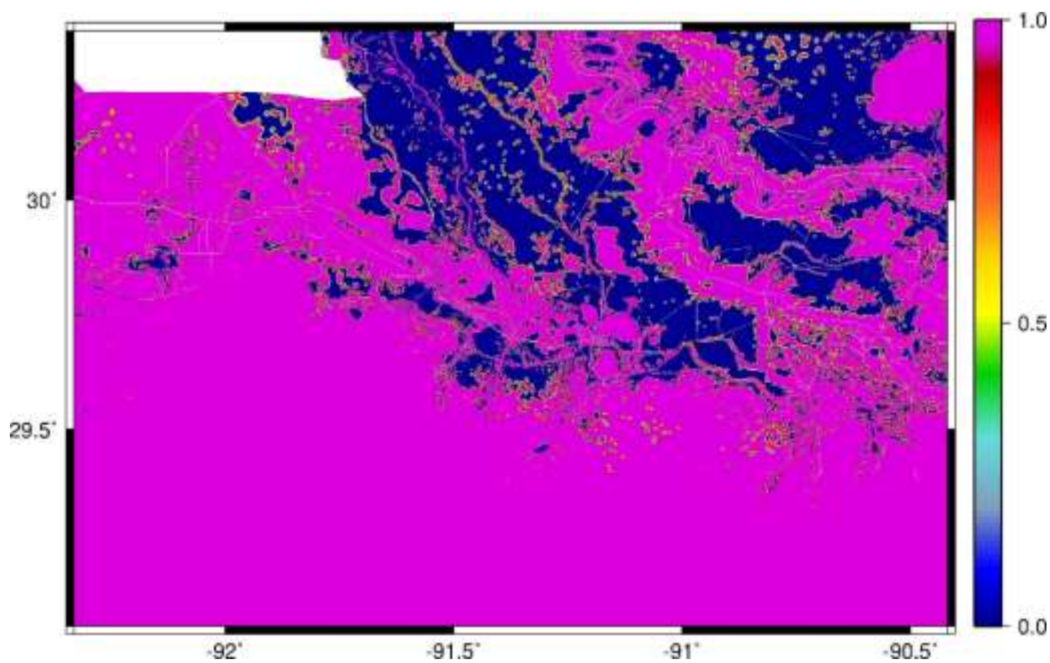

Figure 111. Surface canopy coefficient in ADCIRC at Year 0.

Storm 388 is used to describe impacts within this basin. Storm 388 has a perpendicular track to the coast and makes landfall near Wax Lake Outlet. Surge is pushed against the levees throughout Terrebonne Parish, including the Larose to Golden Meadow Hurricane Protection Project and the Morganza to the Gulf levee system. The peak surge elevation and peak wave height in Year 0 for Storm 388 is shown in Figure 112 and Figure 113.

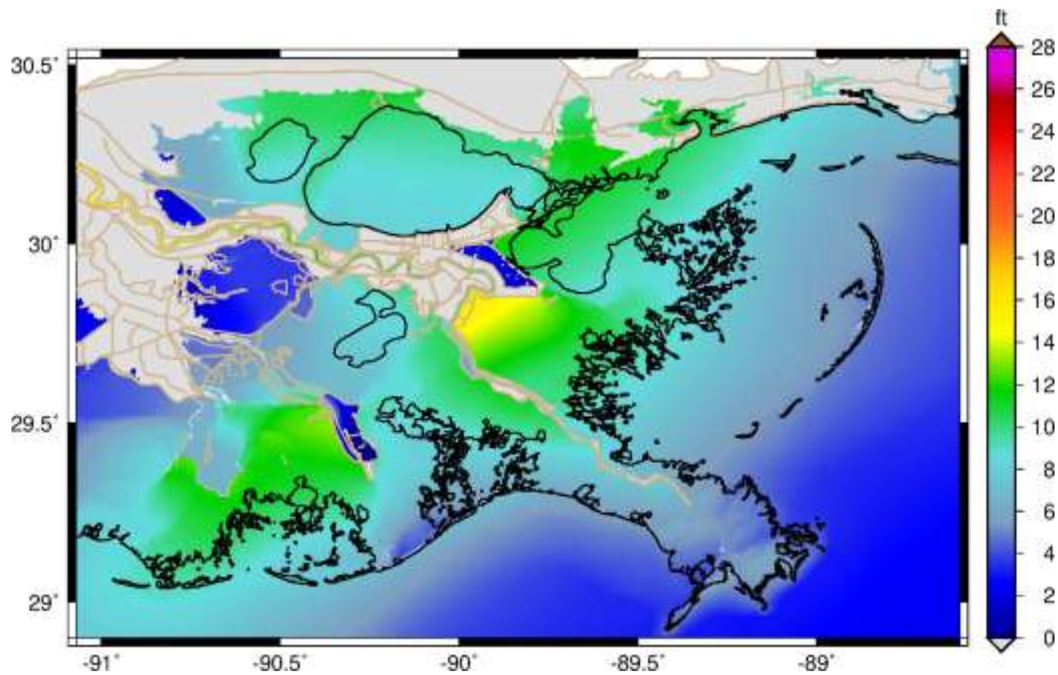

Figure 112. Peak water surface elevation for Storm 388 simulated in Year 0.

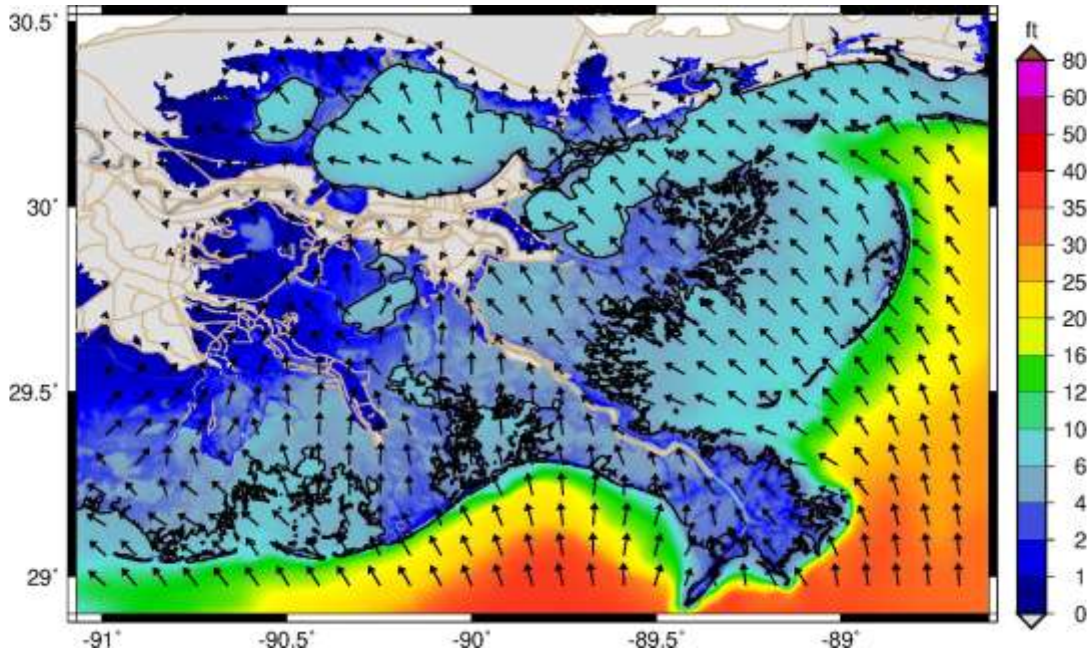

Figure 113. Peak wave height (feet) for Storm 388 in Year 0.

LOWER SCENARIO

In Year 30 and Year 50, the topographic elevations (Figure 114 and Figure 117) provided by the ICM generally show decreases in elevation except near the Atchafalaya River and Wax Lake Outlet deltas, which build land. Frictional coefficients (Figure 115, Figure 116, Figure 118, and Figure 119) generally decrease throughout the region, even with land building in the Atchafalaya Basin. Additional details about the changes in topography, bathymetry, and land use characteristics can be found in White et al. (2023).

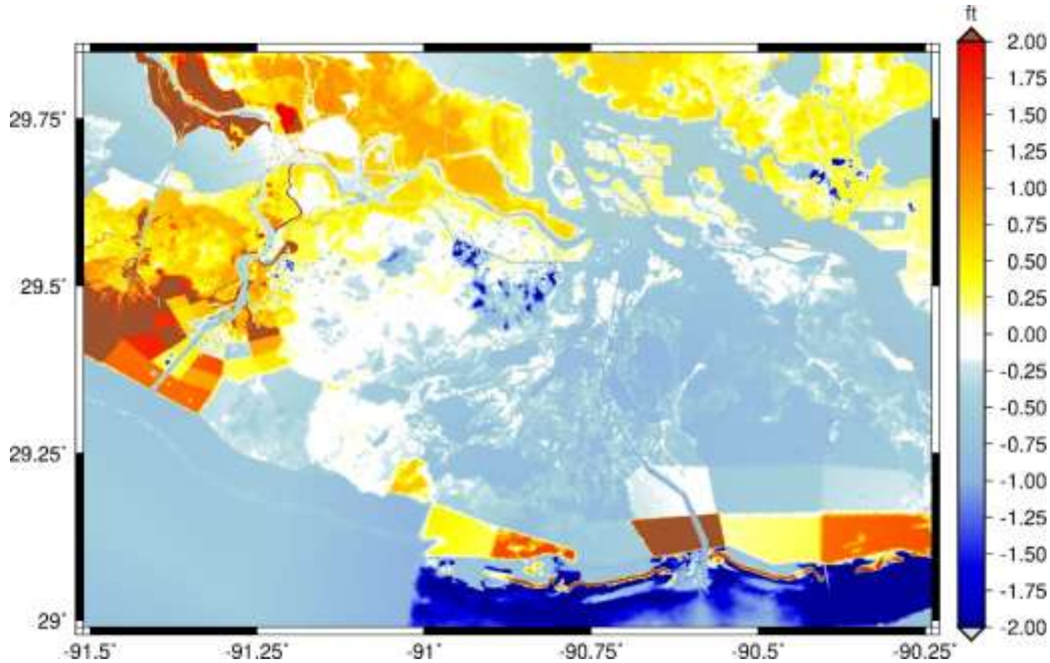

Figure 114. Change in topography and bathymetry in ADCIRC in the lower scenario for Year 30.

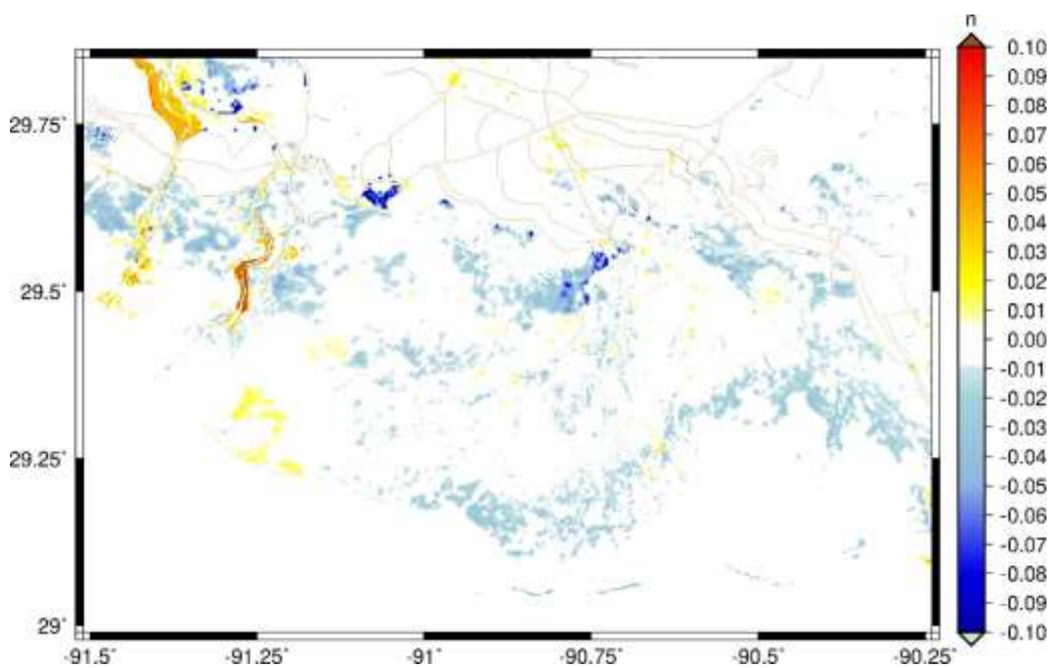

Figure 115. Change in Manning's n coefficient in ADCIRC in the lower scenario for Year 30.

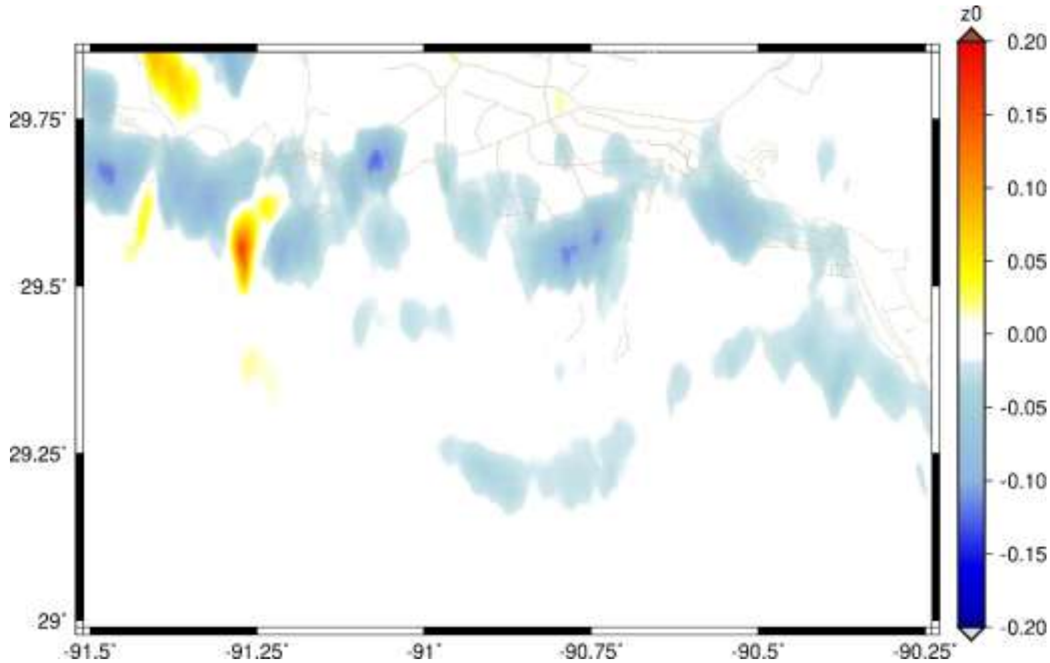

Figure 116. Change in directional wind reduction in ADCIRC in the lower scenario in Year 30.

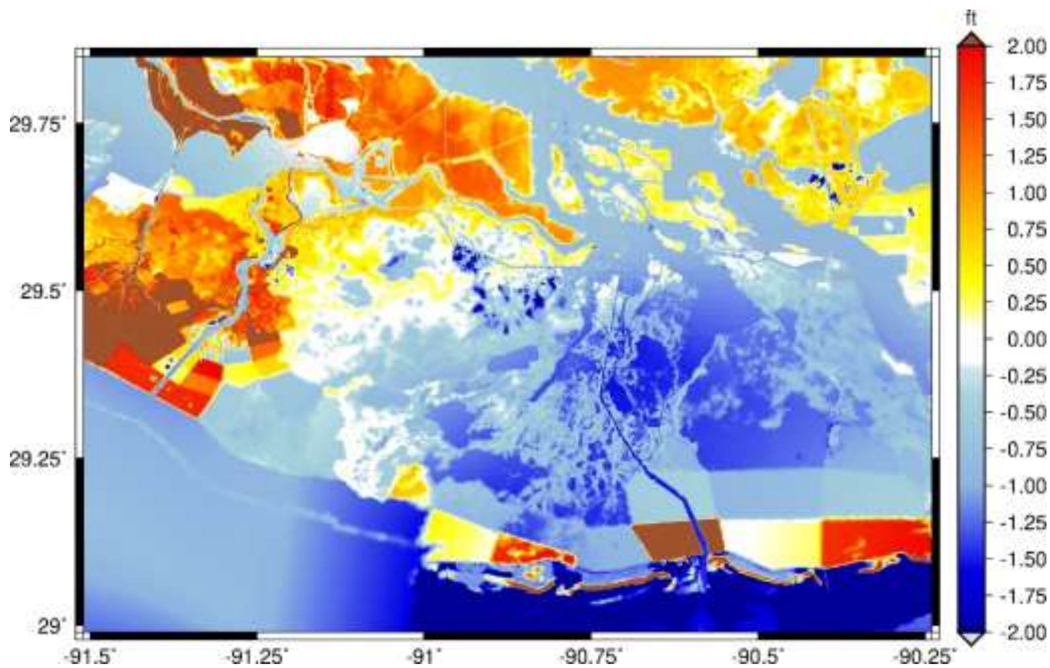

Figure 117. Change in topography and bathymetry in ADCIRC in the lower scenario for Year 50.

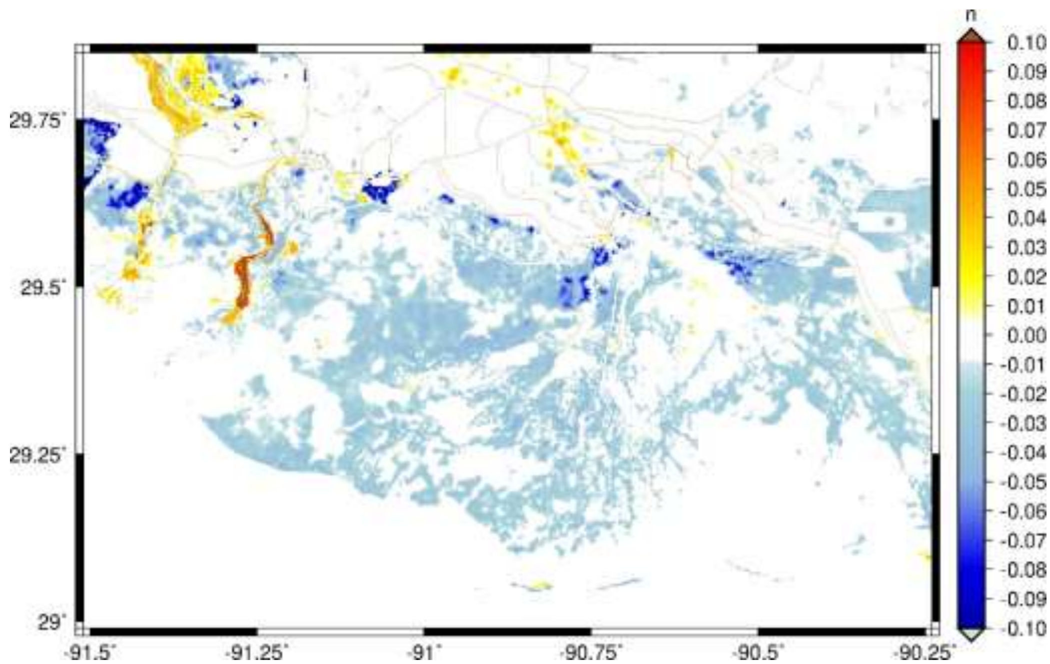

Figure 118. Change in Manning's n coefficient in ADCIRC in the lower scenario for Year 50.

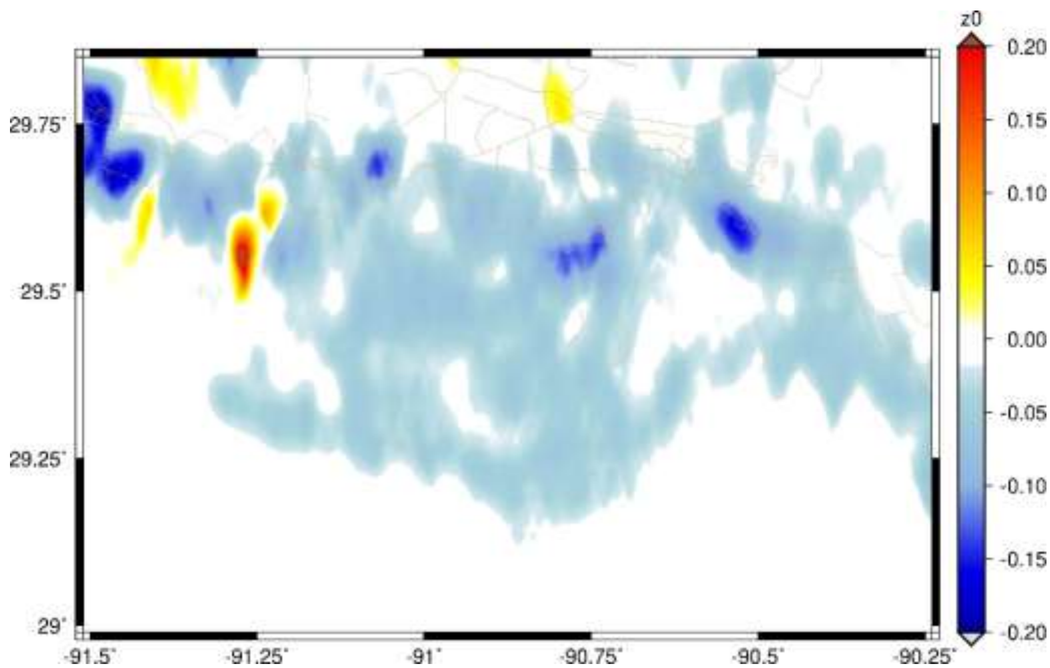

Figure 119. Change in directional wind reduction in ADCIRC in the lower scenario in Year 50.

Storm surge is mostly influenced by SLR. However, areas of Terrebonne show an increase in surge less than the SLR increment, particularly south of the Morganza to the Gulf levee system, because storm surge is able to move further inland with decreasing friction and topographic values (Figure 120 and Figure 122). Surge within the Morganza to the Gulf system increases in excess of the SLR increment because as storm surge more easily penetrates inland, it is more able to wrap around the edges of the system in addition to overtopping from the front side of the system. Changes in wave height (Figure 121 and Figure 123) correspond to increases in total water depth.

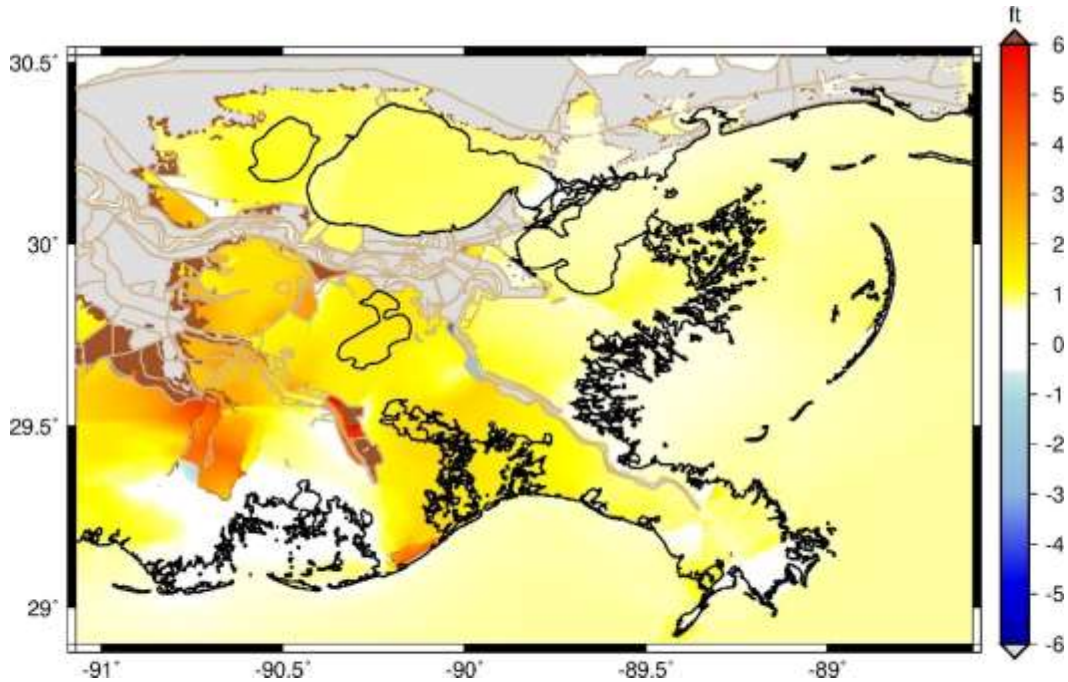

Figure 120. Change in peak water surface elevation between Year 30 and Year 0 in the lower scenario.

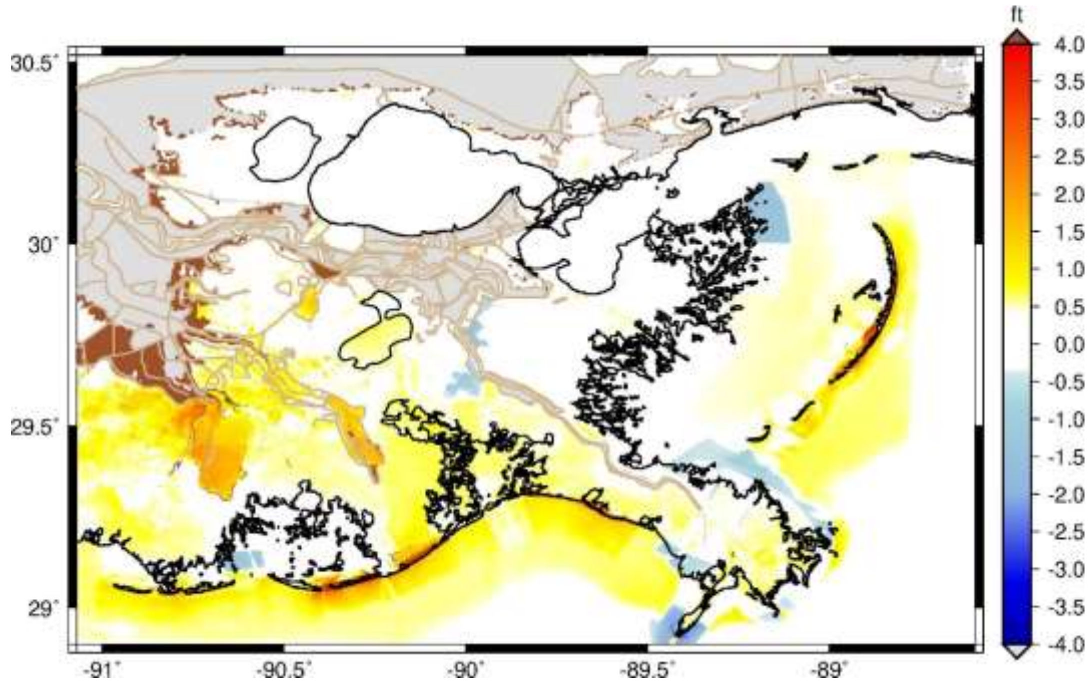

Figure 121. Change in peak wave height between Year 30 and Year 0 in the lower scenario.

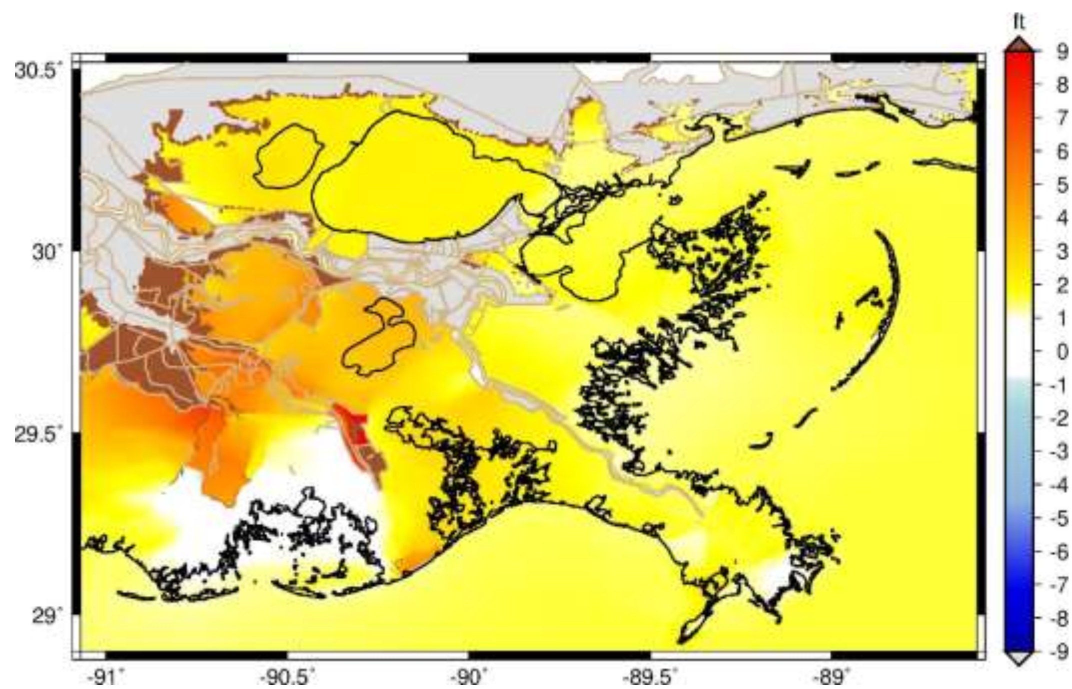

Figure 122. Change in peak water surface elevation between Year 50 and Year 0 in the lower scenario.

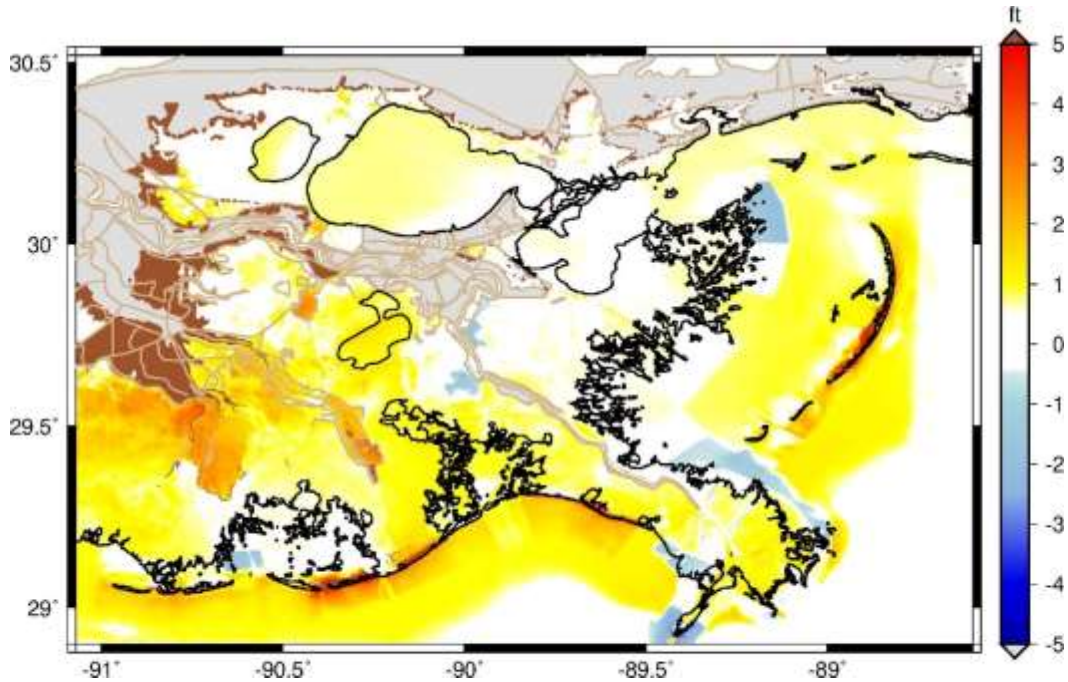

Figure 123. Change in peak wave height between Year 50 and Year 0 in the lower scenario.

HIGHER SCENARIO

In Year 30 and Year 50, the topographic elevations provided by the ICM generally show decreases in elevation except near the Atchafalaya River and Wax Lake Outlet deltas, which build land (Figure 124, Figure 127). Frictional coefficients generally decrease throughout the region, even with land building in the Atchafalaya Basin (Figure 125, Figure 126, Figure 128, and Figure 129). Additional details about the changes in topography, bathymetry, and land use characteristics can be found in White et al. (2023).

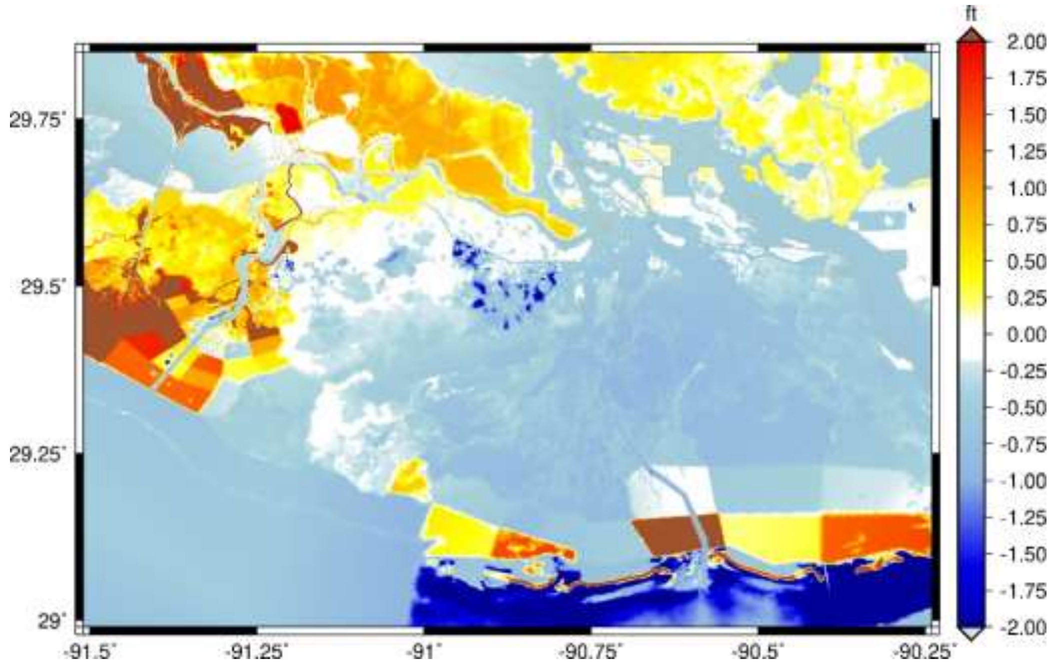

Figure 124. Change in topography and bathymetry in ADCIRC in the higher scenario for Year 30.

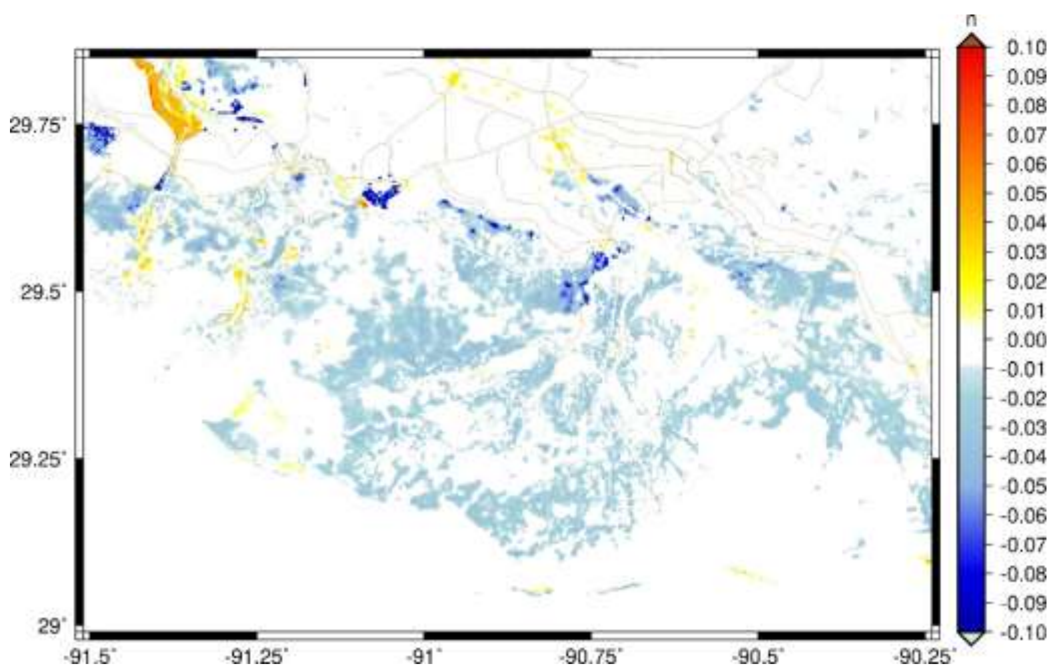

Figure 125. Change in Manning's n coefficient in ADCIRC in the higher scenario for Year 30.

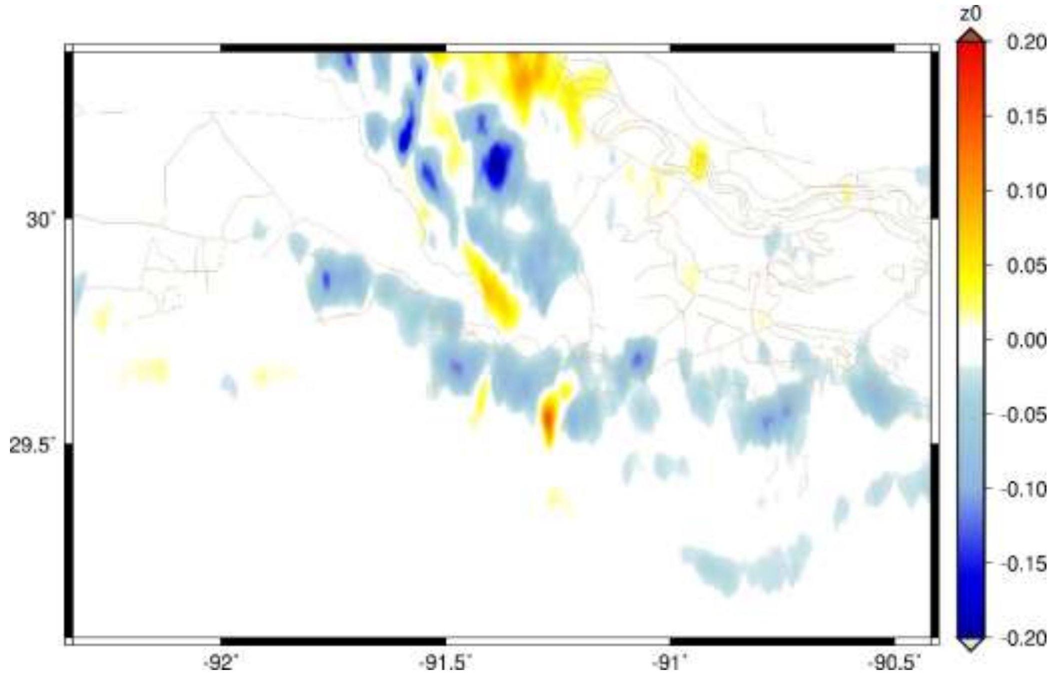

Figure 126. Change in directional wind reduction in ADCIRC in the higher scenario in Year 30.

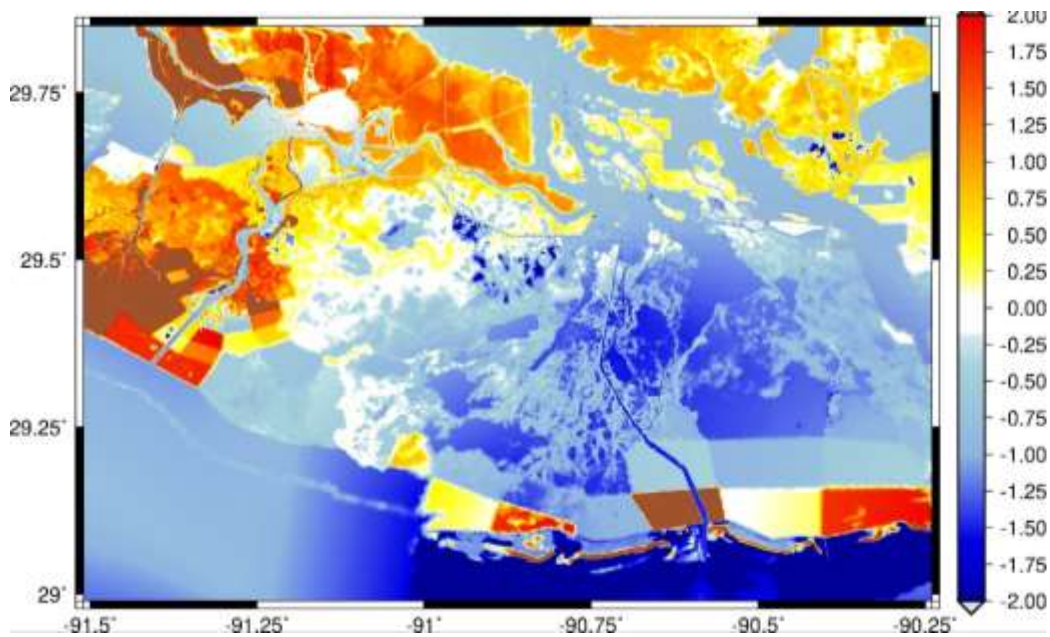

Figure 127. Change in topography and bathymetry in ADCIRC in the higher scenario for Year 50.

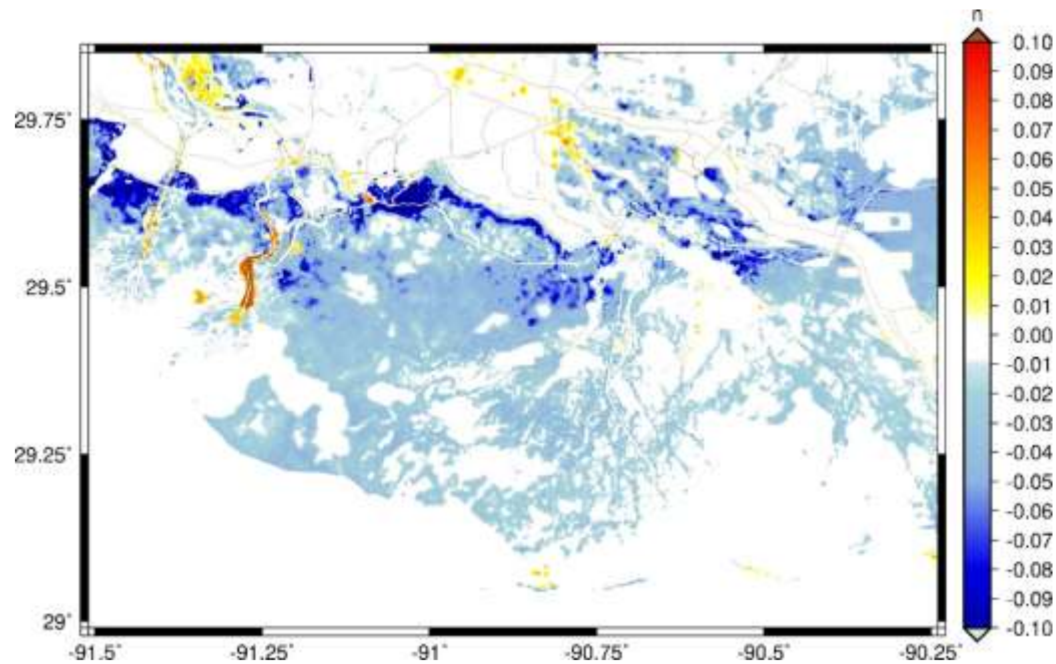

Figure 128. Change in Manning's n coefficient in ADCIRC in the higher scenario for Year 50.

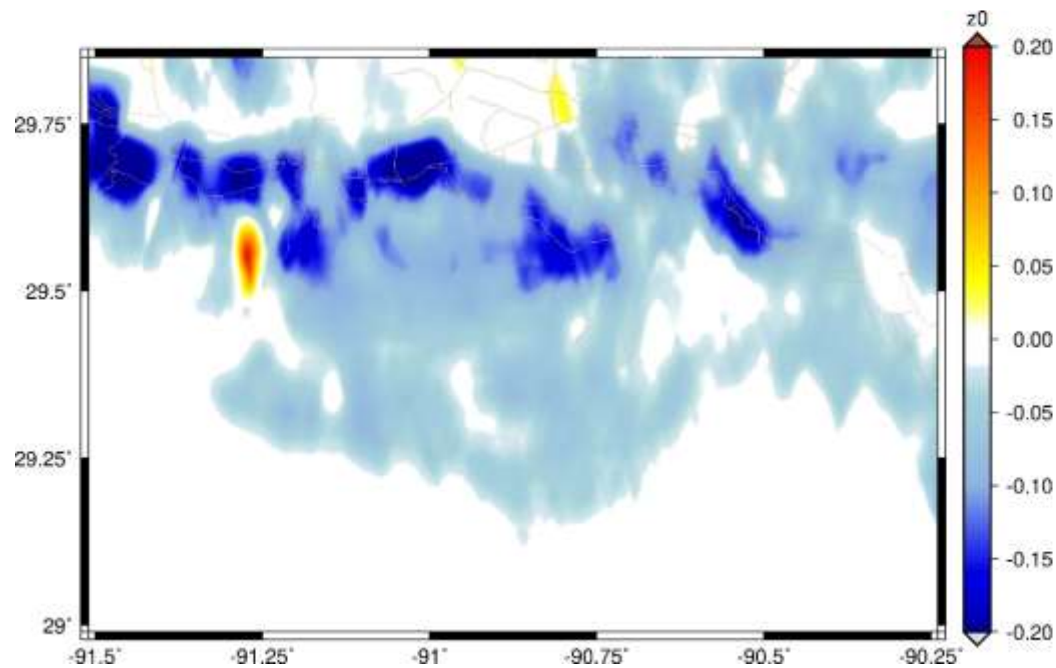

Figure 129. Change in directional wind reduction in ADCIRC in the higher scenario in Year 50.

Storm surge results in the higher scenario are similar to the lower scenario, though the magnitude is greater due to the increased SLR value. The area south of the Morganza to the Gulf levee system continues to show a change in peak water surface elevation less than the increment of SLR in both Year 30 and Year 50 (Figure 130 and Figure 132). The inundated area extends most of the way through the Upper Terrebonne Basin by Year 50. Changes in wave height are due to changes in total water depth (Figure 131 and Figure 133).

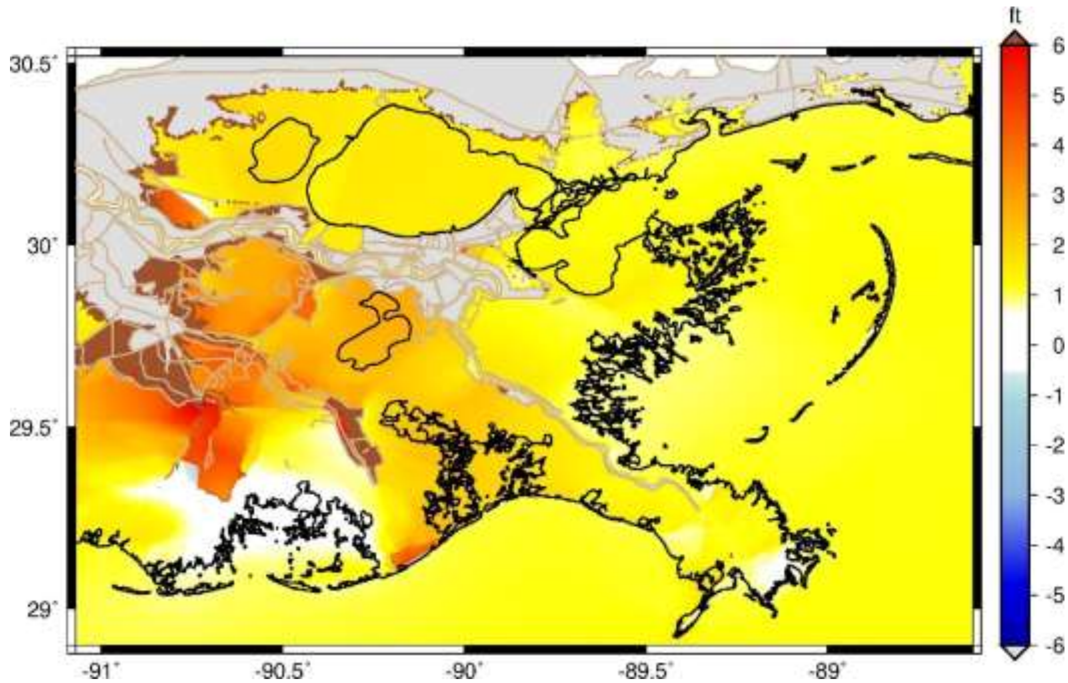

Figure 130. Change in peak water surface elevation between Year 30 and Year 0 in the higher scenario.

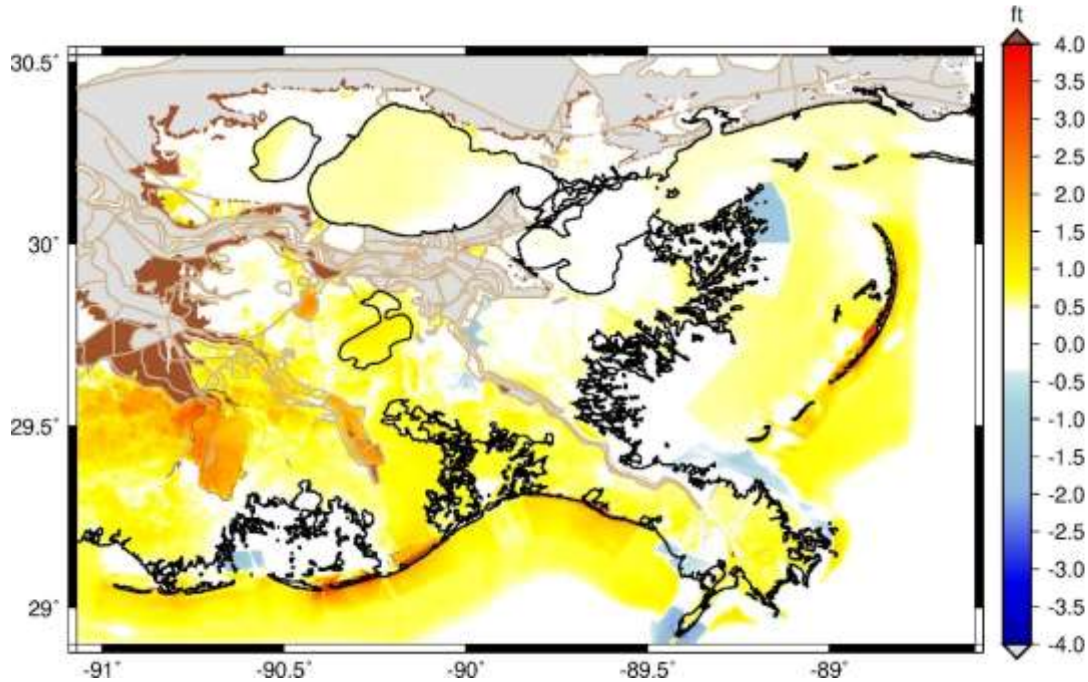

Figure 131. Change in peak wave height between Year 30 and Year 0 in the higher scenario.

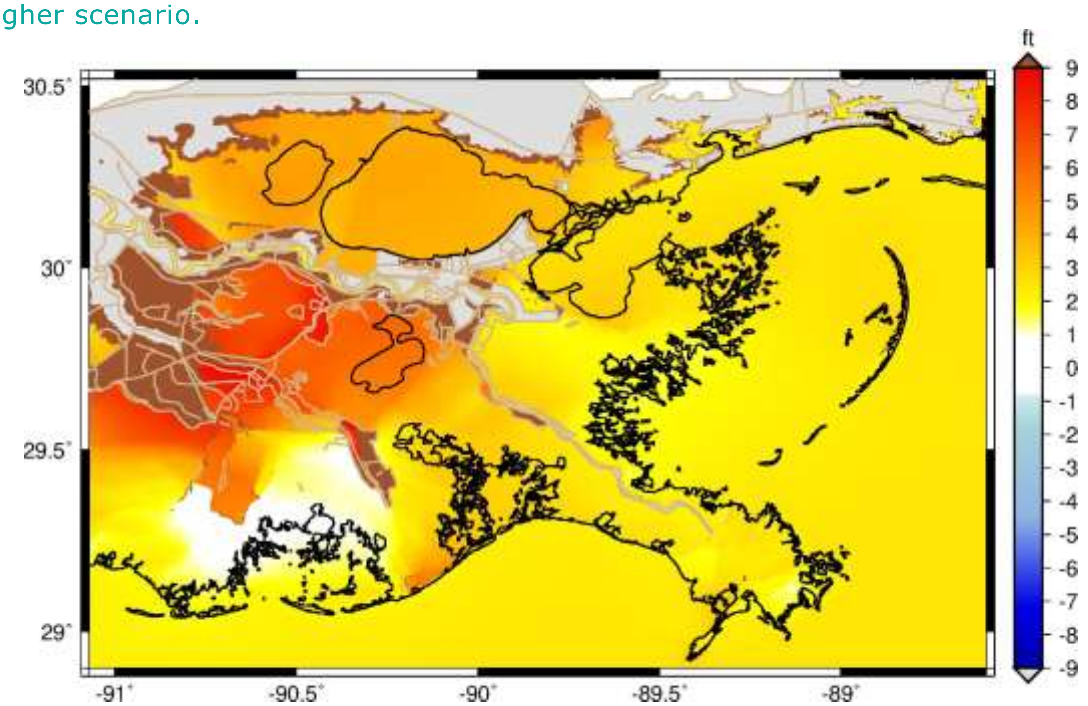

Figure 132. Change in peak water surface elevation between Year 50 and Year 0 in the higher scenario.

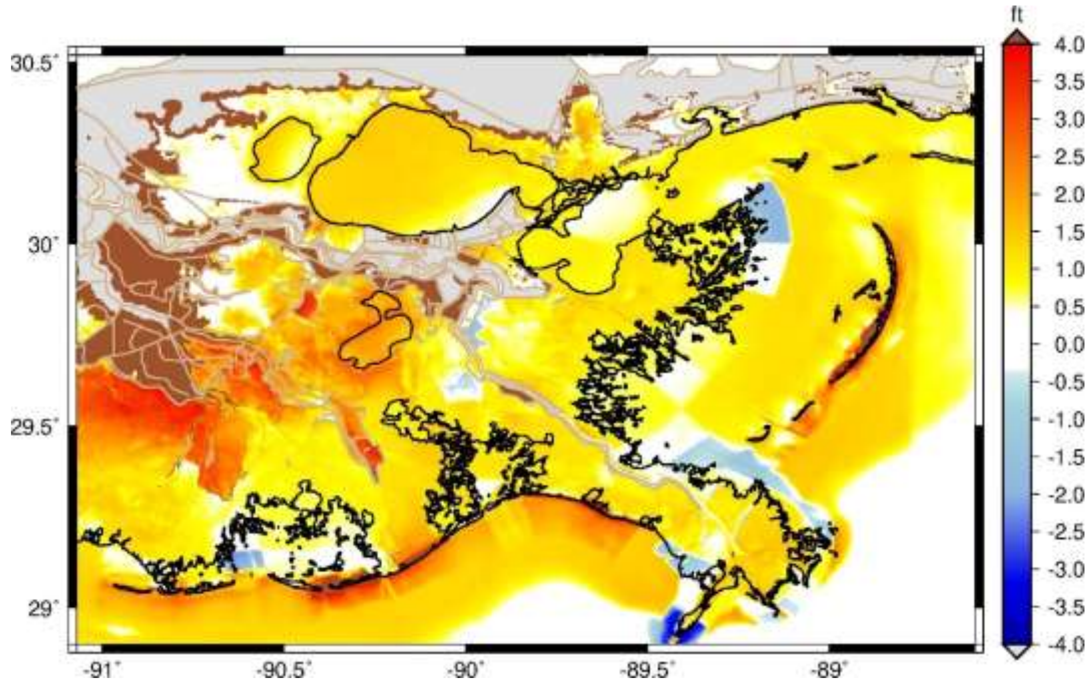

Figure 133. Change in peak wave height between Year 50 and Year 0 in the higher scenario.

4.4 FLOOD DEPTH PROJECTIONS

LOWER SCENARIO

In the lower scenario, flood depth exceedances are generally greatest in the southeastern portion of Terrebonne, from the edge of the Larose to Golden Meadow Hurricane Protection Project in the east, through Point-aux-Chenes and Isle de Jean Charles going westward to Cocodrie and Dularge. Local levees (indicated as grey lines in maps) provide some degree of surge attenuation to smaller bayou communities, seen in Figure 134, for example, as the transition from 10% AEP flood depths of 10-12 feet to 7-10 feet or less along Bayou Terrebonne, running south from Montegut to Cocodrie, and the Falgout Canal between Bayou Dularge and the Houma Navigation Canal.

West of Dularge, 10% AEP flood depths are lower, from 4 to 7 feet directly to the west in Year 20 and increasing to 7 to 12 feet by Year 50. In this western Terrebonne area, the 10% AEP floodplain extends north up the Atchafalaya, yielding 1 to 4 feet of inundation around Amelia and between Lake Palourde and Lake Verret. In the eastern half of the basin, similar flooding extends north to Houma and Raceland, but not all the way to Thibodaux, even in later years.

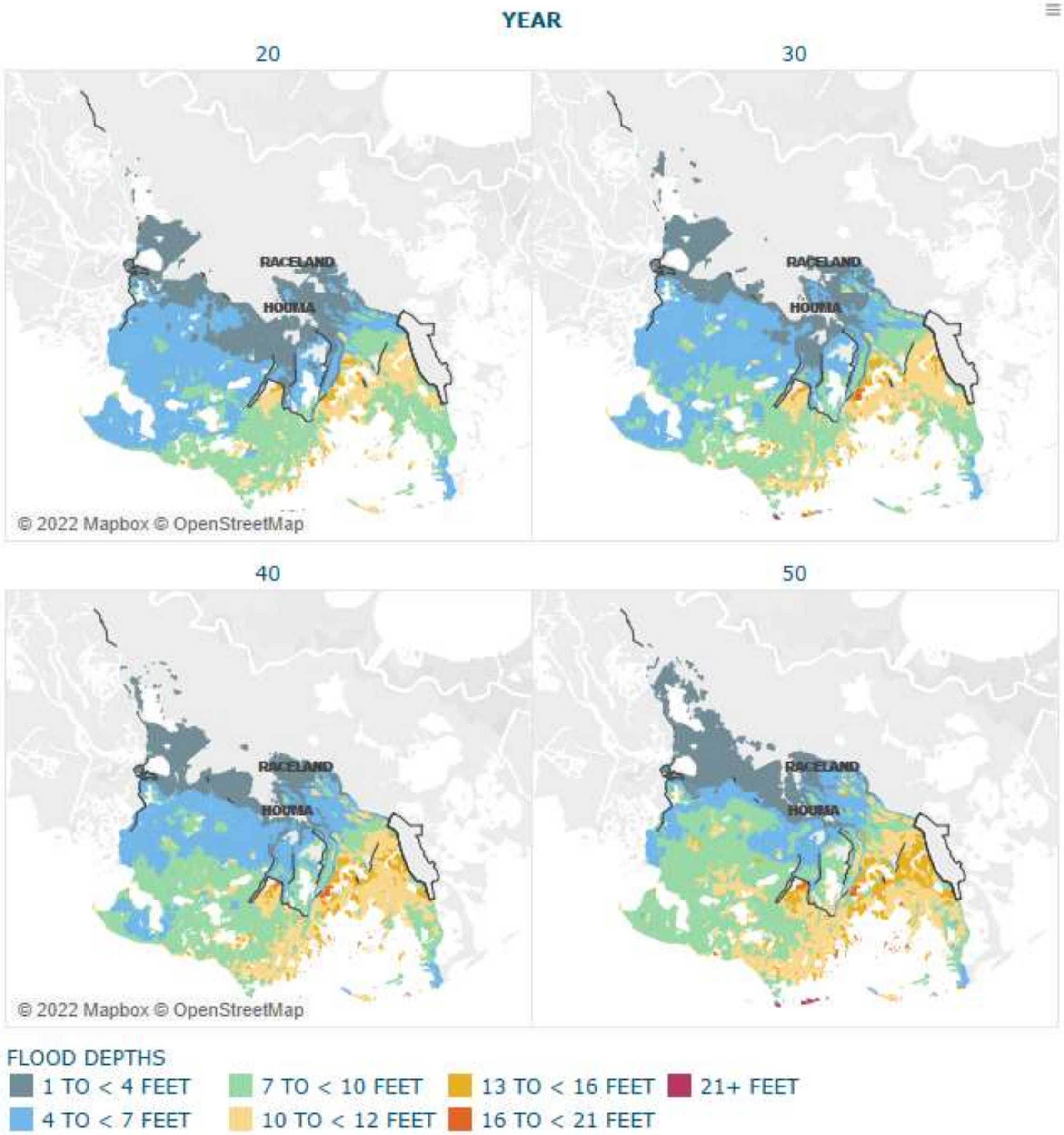

Figure 134. 10% annual chance (1 in 10-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The 1 in 10-year floodplain does not penetrate inland to the populated areas along Bayou Terrebonne north of the Larose to Golden Meadow Hurricane Protection Project. This means that the most striking increases in flood depths over time are along this ridge (Figure 135). Another area where flood depths increase notably is just between Chauvin and Montegut, as State Road 56 provides some protection to parts of Chauvin on the west side of Bayou Petit Caillou, consequently leading to some surge build-up on the east side. With the exception of these areas, the 10% AEP flood depths increase by about 1 foot or less per decade.

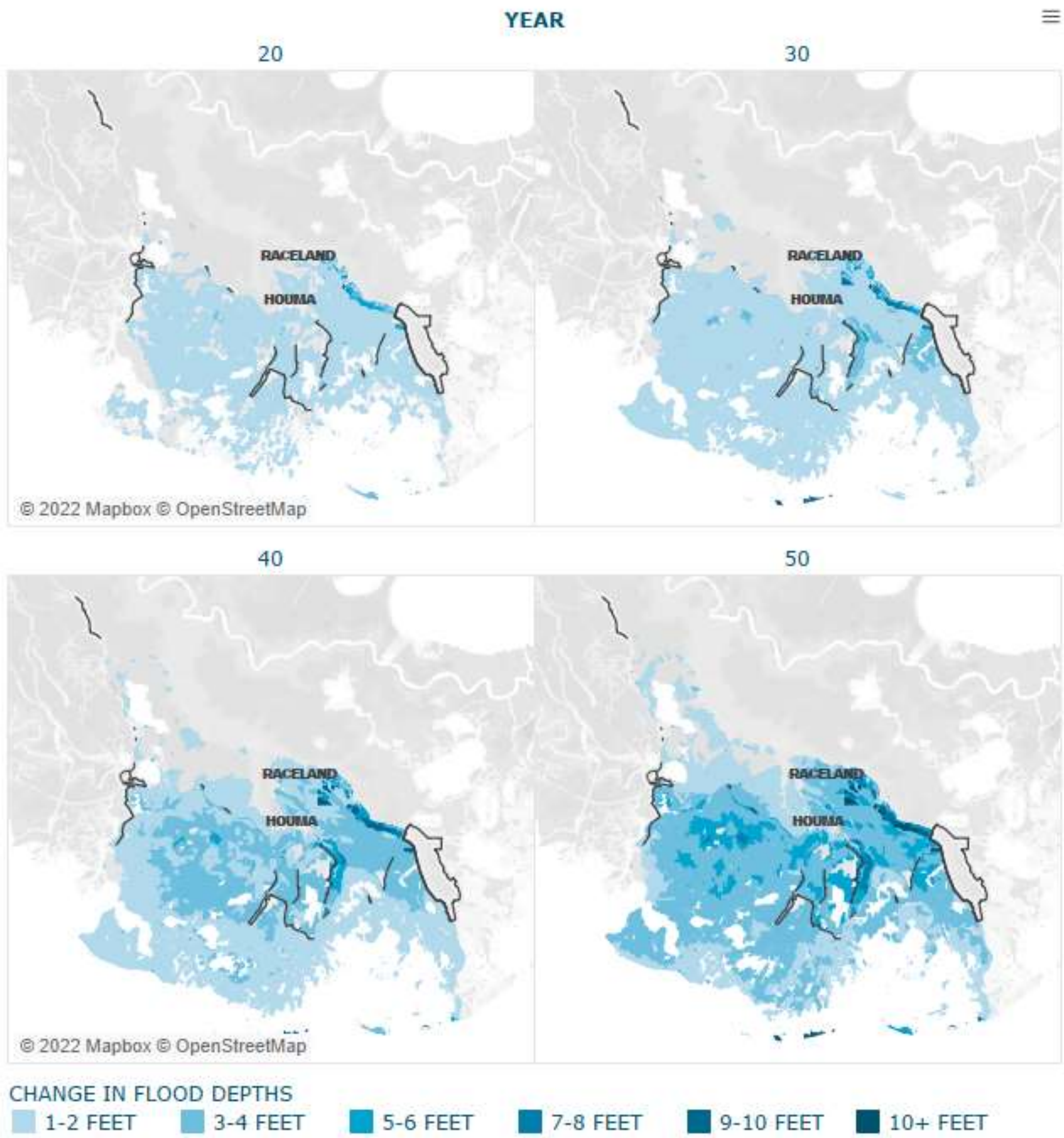

Figure 135. Change in 10% annual chance (1 in 10-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The 1% AEP flood depths in Terrebonne are greatest in the Point aux Chenes area between

Chauvin/Montegut and the Larose to Golden Meadow Hurricane Protection Project, and in the small area between Dularge and Dulac (Figure 136). The spatial pattern of flooding is similar to that of the 10% AEP depths, though the values are substantially higher. These areas with highest hazard have 1% AEP flood depths over 16 feet even in current conditions, but a large proportion of the region exceeds this threshold by years 40 and 50. The floodplain does not extend much farther inland in years 20 and 30 than the 10% AEP floodplain, but later years see expansion north of Lake Verret to encompass Pierre Part in Assumption Parish.

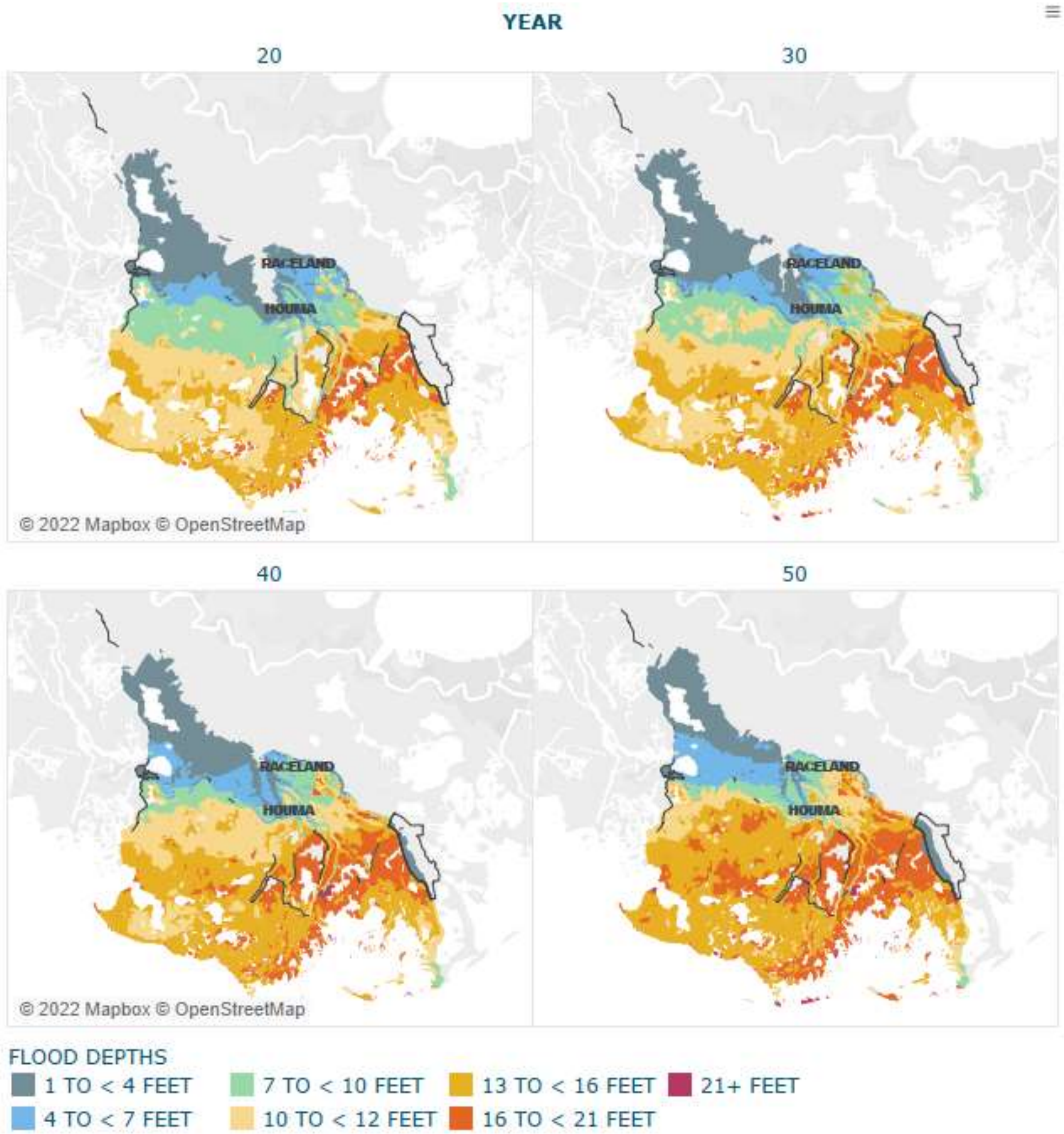

Figure 136. 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The changes in the 100-year flood depths over time are a visual departure from the pattern of changes in the 10-year floodplain (Figure 137). Under current conditions, local levees and existing components of the Morganza to the Gulf levee system provide a substantial reduction in flood depths with a 1% AEP. They lose their ability to reduce inundation from such extreme events over time, however, resulting in an increase in 1% AEP depths of approximately two feet per decade in areas behind those features located south and west of Houma.

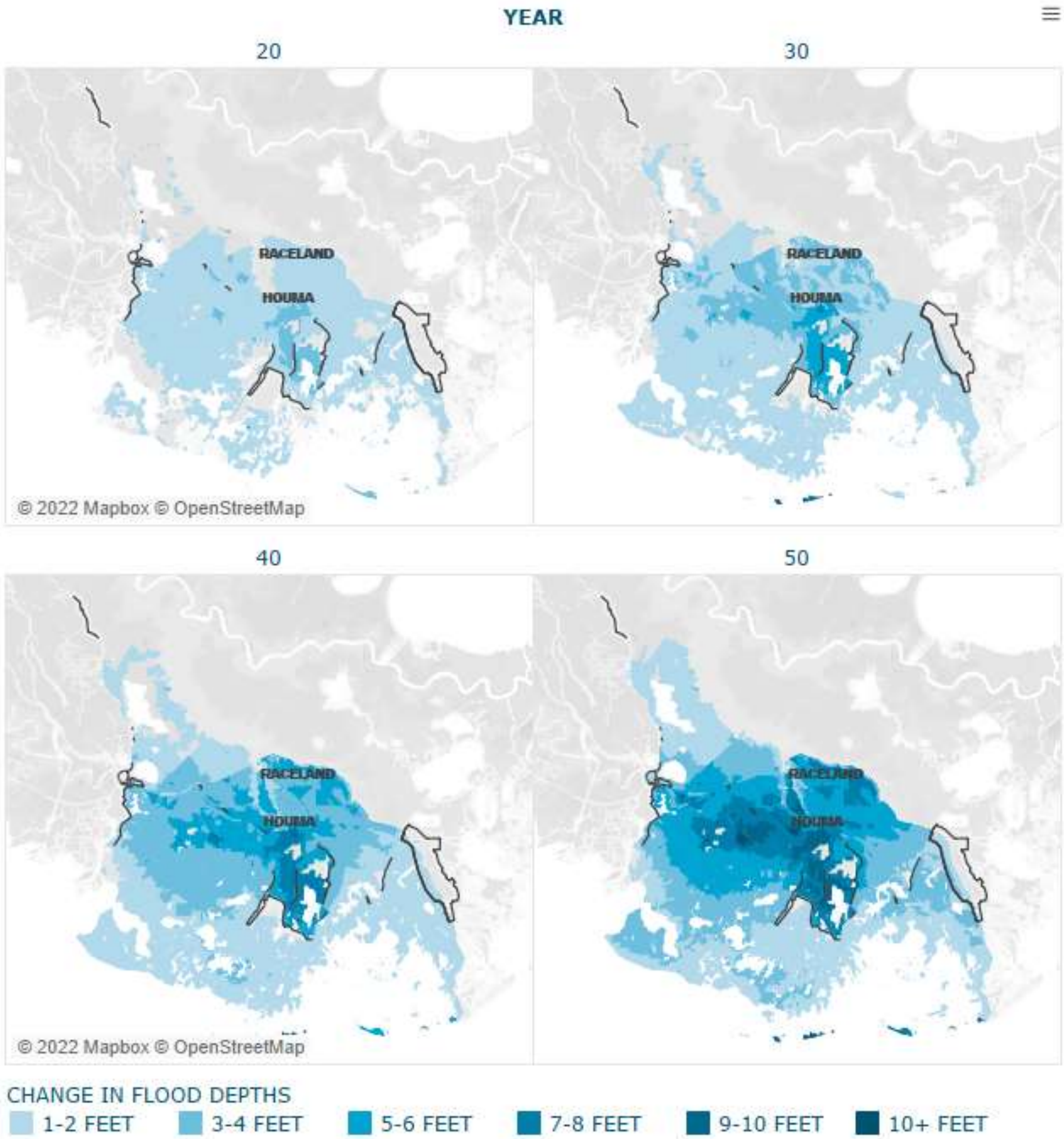

Figure 137. Change in 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

HIGHER SCENARIO

In the higher scenario, the spatial pattern of 1 in 10-year flood depth exceedances is similar to that in the lower scenario. Inundation is generally greatest in the southeastern portion of the Terrebonne region, from the edge of the Larose to Golden Meadow Hurricane Protection Project, westward to Cocodrie, Dulac, and Dularge. Existing protection elements provide some degree of reduction in flooding to these bayou communities (Figure 138), resulting in the greatest 10% AEP inundation caused by surge pileup in front of these features.

West of Dularge, these flood depth exceedances are several feet lower in years 20 and 30 than areas east of the community at similar latitude. In later decades, however, 10% AEP flood depths become more similar across points in the region at the same latitude, with some Year 50 values over 13 feet between Amelia and Bayou Shaffer in the west, as well as around Lockport and Mathews in the east. Further north around Lake Verret, the 10% AEP floodplain in Year 50 extends as far as the 1% AEP floodplain in the lower scenario.

Under current conditions, the 1 in 10-year floodplain does not penetrate inland to the populated areas along Bayou Terrebonne north of Larose. By Year 20 of the higher scenario, though, inundation extends into areas like Lockport and Bayou Blue, though Raceland and Houma remain largely dry (Figure 139). Communities along Bayou Lafourche are projected to see the largest increases in depth exceedances at this return period. Contrasting with the lower scenario, some areas south of U.S. Highway 90 between Houma and Morgan City do see similar increases by Year 50.

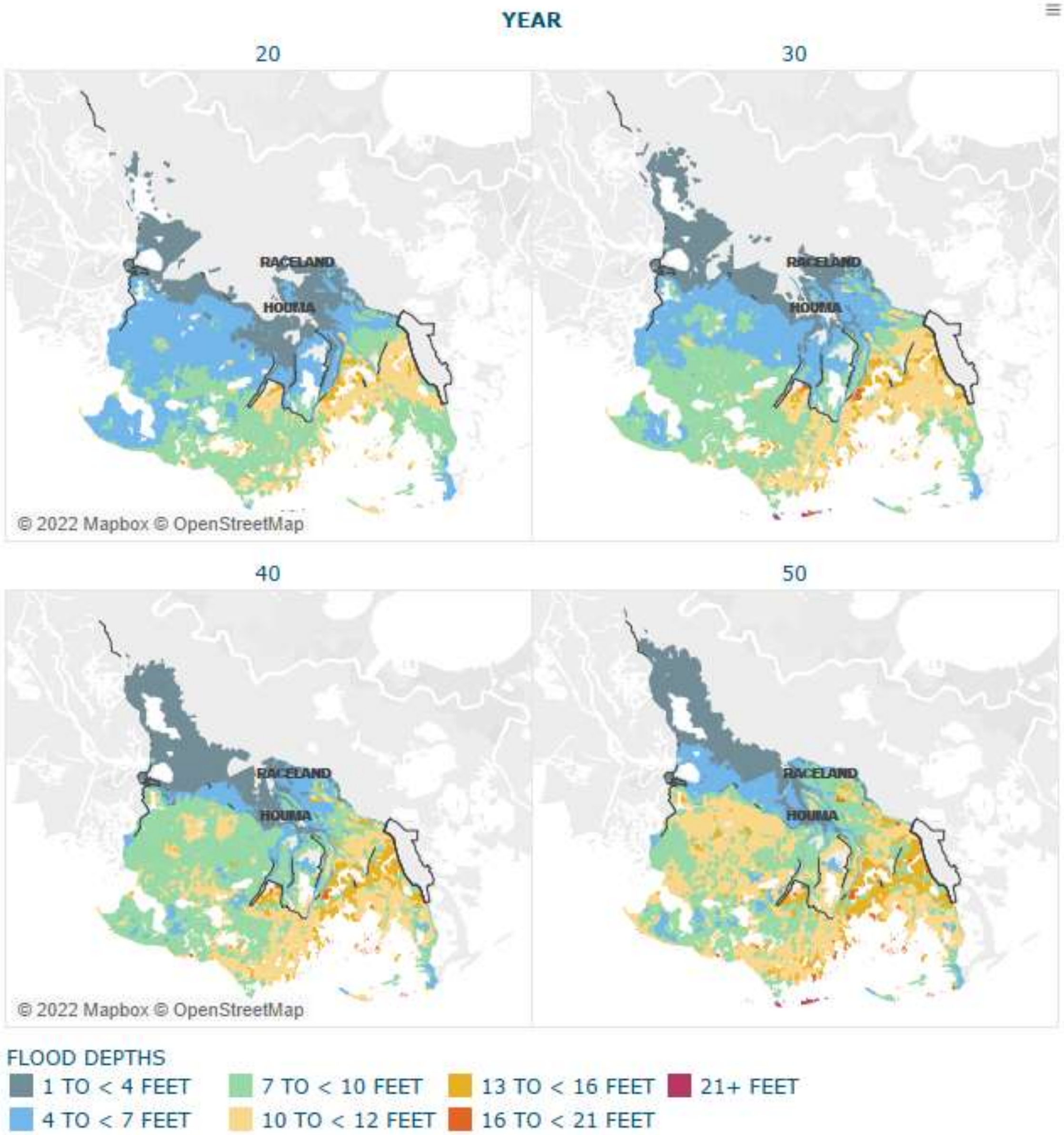

Figure 138. 10% annual chance (1 in 10-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

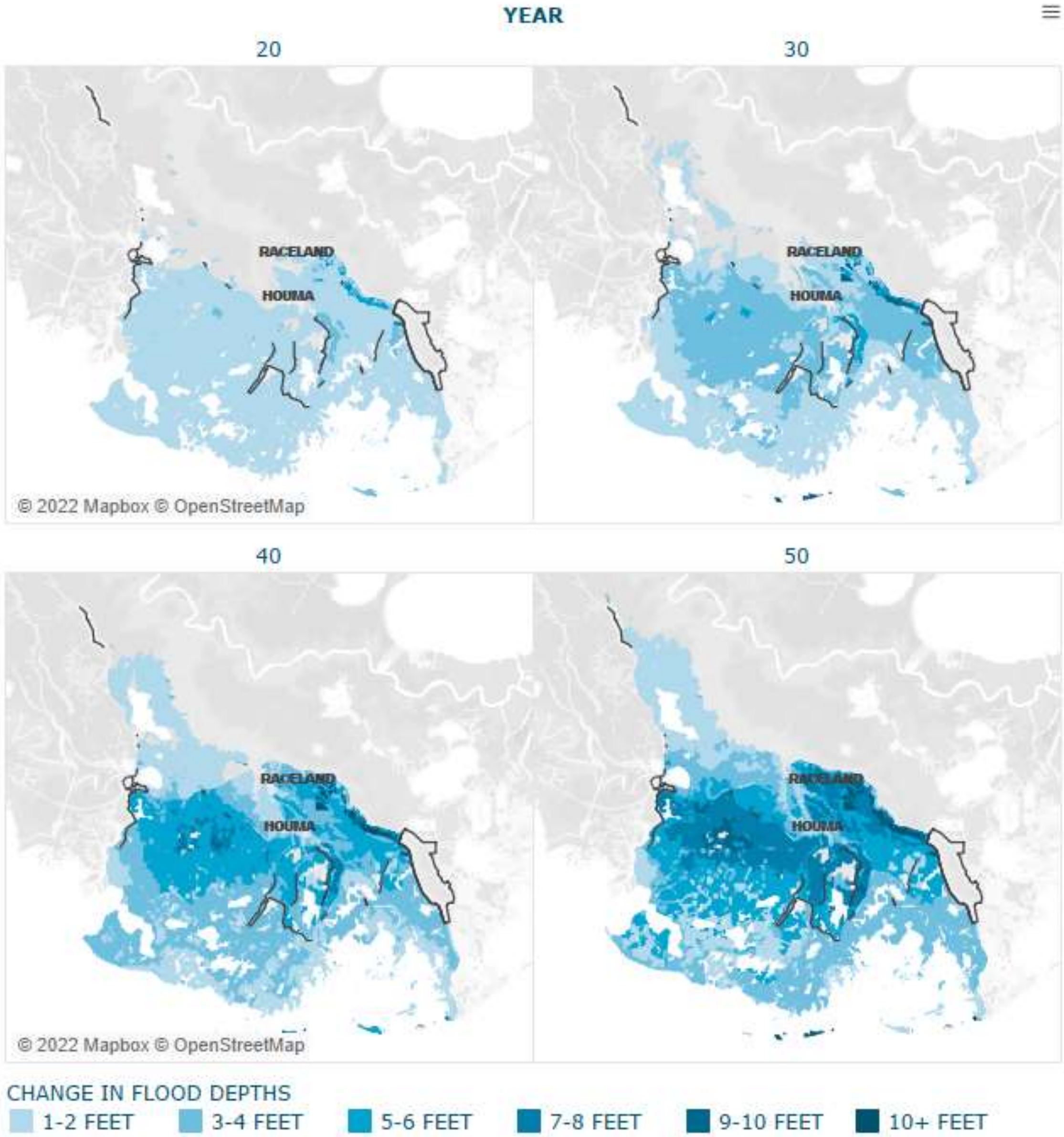

Figure 139. Change in 10% annual chance (1 in 10-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Terrebonne's 1% AEP flood depths in the higher scenario (Figure 140) are greatest in the Point aux Chenes area between Chauvin/Montegut and the Larose to Golden Meadow Hurricane Protection Project and in the small area between Dularge and Dulac. Large portions of the region see depth exceedances from 16 to 21 feet by Year 50, though in all years there is a clear contour along State Road 182 where its elevation reduces flooding to the north between Amelia and Houma.

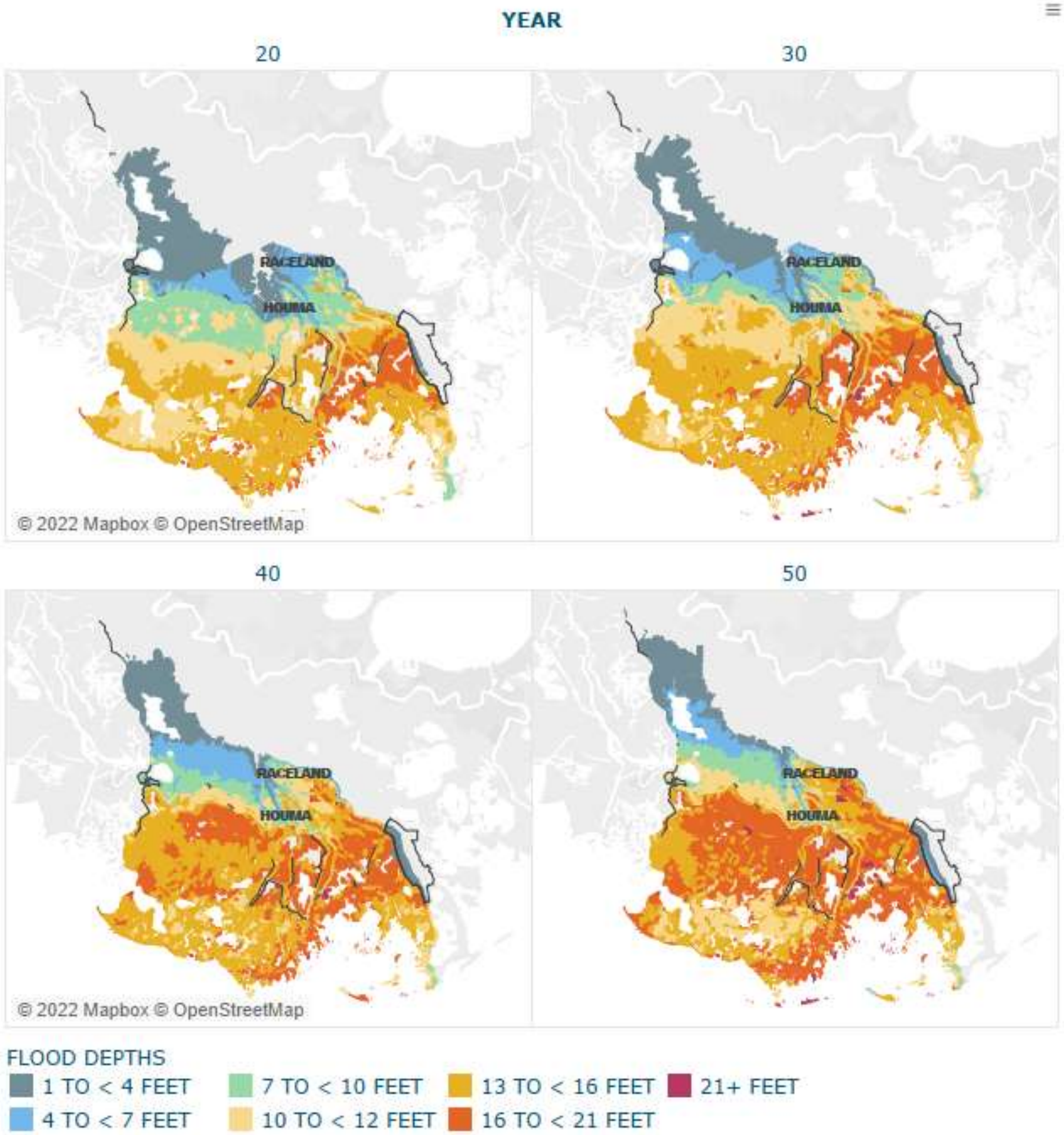

Figure 140. 1% annual chance (1 in 100-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

In Year 50, because of land building south and west of Dularge, 100-year depths decrease between years 30 and 50, with values between 10 and 12 feet at the end of the planning horizon. That is not the case further inland, however, with most of Terrebonne (from Dularge, Dulac, and Chauvin extending north to Morgan City, Houma, and Raceland) projected to experience increases in 1% AEP flood depths of 7 feet or more (Figure 141).

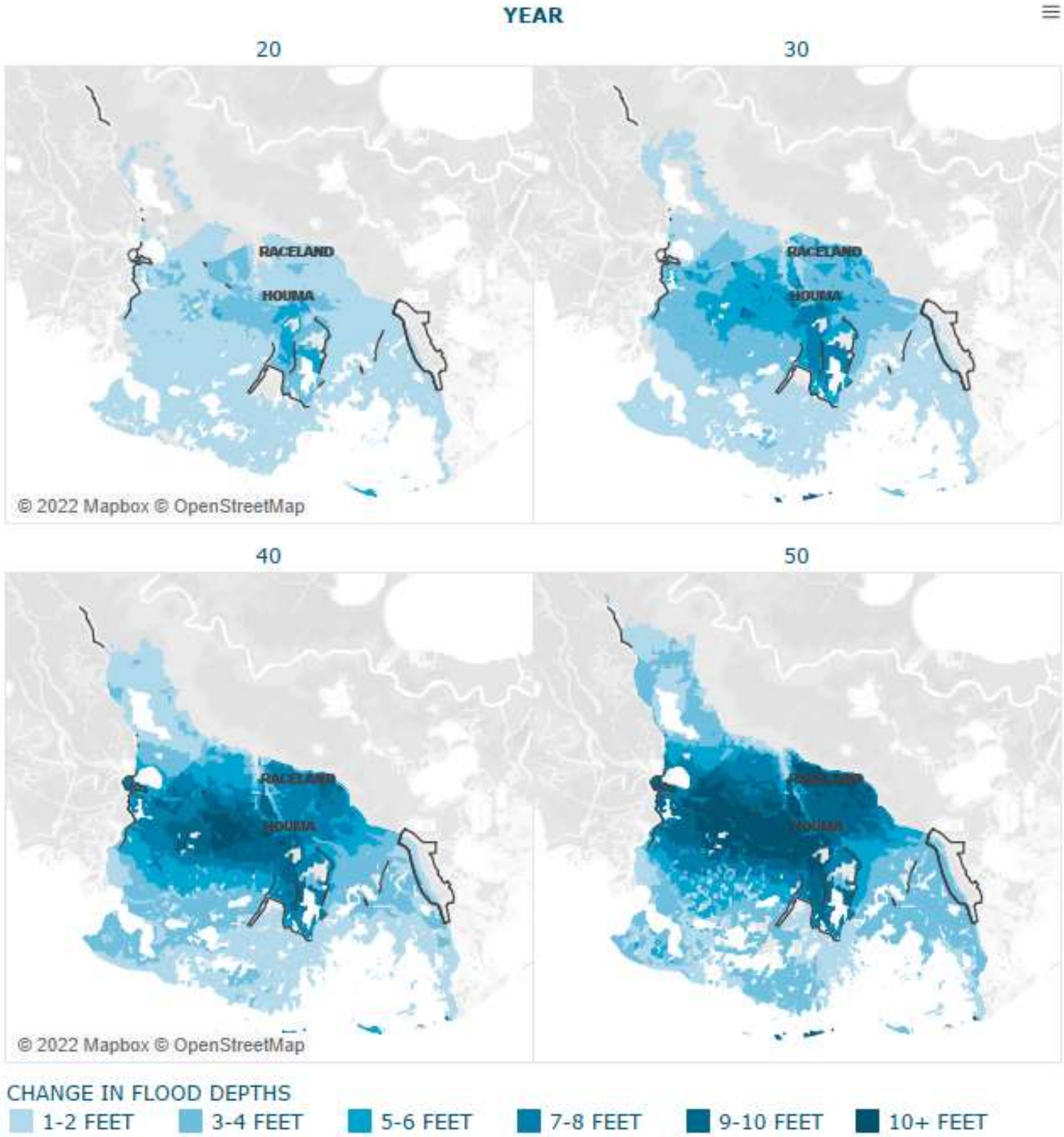

Figure 141. Change in 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

DISCUSSION

Hazard estimates for the Terrebonne region show increases in the both the extent and depth of flooding over the period of analysis. The temporal pattern of hazard is complicated by the presence of local protection features that are not federally accredited and lose their benefits over time with degradation and rising sea levels. The mouth of the Atchafalaya River is also projected to build some land in the delta over time; this results in, for example, 1% AEP flood depths southwest of Dularge peaking around Year 30 then decreasing over the remaining 20 years of the planning horizon.

Similarly, the parts of Terrebonne behind enclosed protection systems are projected to experience non-linear increases in flood depth exceedances at various return periods as the decades progress. Both the Larose to Golden Meadow Hurricane Protection Project and the Morgan City levee system are estimated to lose their 100-year protection around 2070 in the lower scenario and 2060 in the higher scenario. While the Cut Off/Galliano/Golden Meadow community continues to experience much lower depth exceedances than the surrounding area after the 1% AEP level of protection is lost, Morgan City is projected to see similar depth exceedances in 2070 as nearby unprotected areas like Amelia.

4.5 FLOOD DAMAGE PROJECTIONS

LOWER SCENARIO

As previously noted, the Terrebonne region is bordered on the east by Bayou Lafourche, from Donaldsonville in the north to Port Fourchon in the south. It extends westward from Barataria to Little Tensas Bayou along State Highway 997/70 north of Morgan City, then to Bayou Shaffer and the Atchafalaya River south of Morgan City. Larger populations located in Morgan City and along Bayou Lafourche face relatively lower exposure, but many smaller communities dispersed throughout the central areas of the region at low elevation are much more exposed to flood hazard now and in future years. Figure 142 illustrates this, showing that virtually 100% of single-family residential structures are exposed to flooding with a 2% AEP from Year 20 onward in communities south of Houma.

The majority of such assets are exposed at the same return period in Morgan City, with 61% in Houma in Year 20, climbing to over 85% in later decades. Within the Larose to Golden Meadow Hurricane Protection Project and west of Bayou Lafourche, however, exposure remains much lower, less than 10% in all future years modeled.

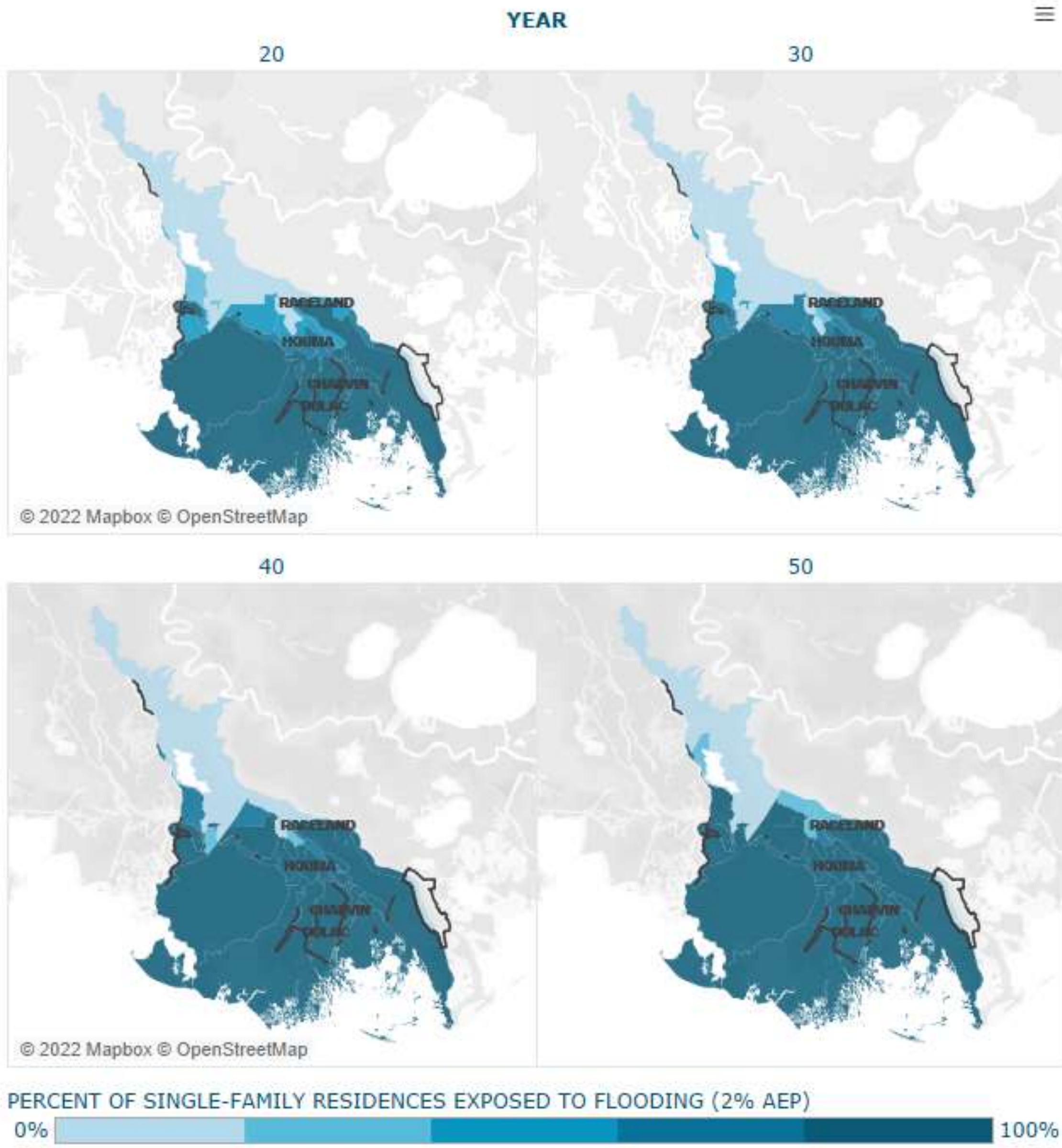

Figure 142. Residential structures exposed to 2% annual chance (1 in 50-year) flood depths above first floor elevation in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Among residential assets not currently exposed to flooding at a 2% AEP, fewer than half in the Terrebonne region remain so over the entire planning horizon (Figure 143). Those that remain unexposed are primarily located in areas with enclosed levee systems (e.g., Morgan City, Galliano) or inland along Bayou Lafourche (e.g., Thibodaux).

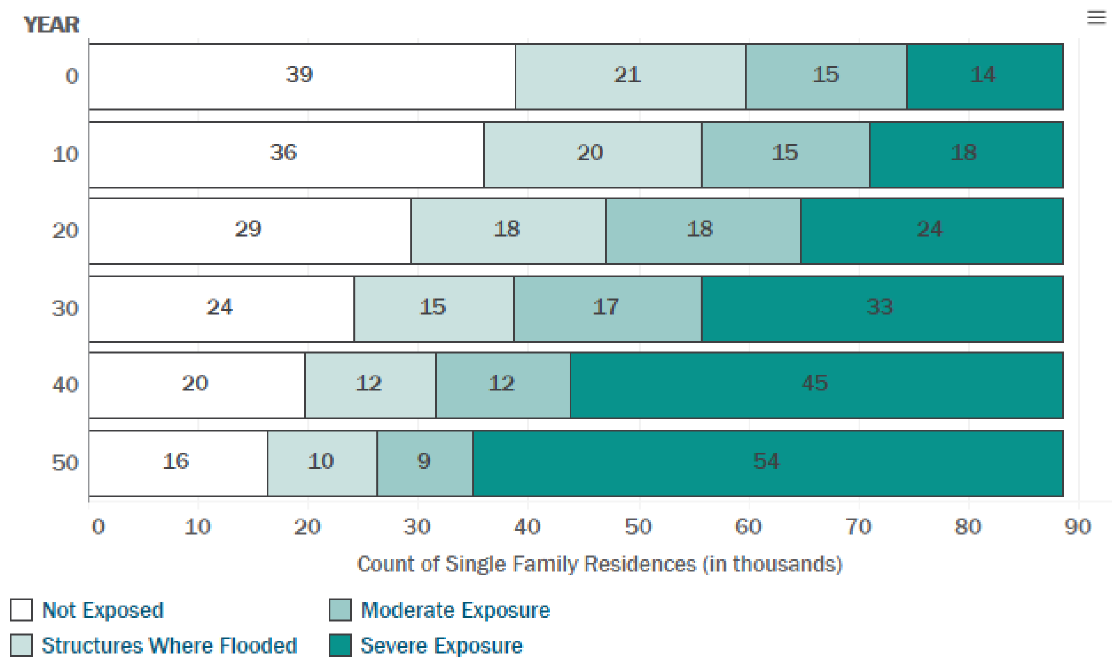

Figure 143. Residential structures exposed to 2% annual chance (1 in 50-year) flooding by exposure category in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile. Note: existing residences only, not accounting for population change.

On the other end of the spectrum, the percentage of residential assets facing severe exposure (i.e., flooding two feet or more above first-floor elevations) is projected to nearly quadruple over the next 50 years, rising from 14% in 2020 to 54% by 2070 and leaving only 19% exposed but to a lesser degree. The increase in severe exposure is expected to accelerate over the next 40 years.

Aggregated over the entire region, the temporal increases in EADD and EASD are highly correlated (Figure 144) and characterized by a sharp acceleration from Year 20 onwards. The total increase is greater proportionally for EADD, with Year 50 representing about 4.75 times the 2020 estimate; the corresponding figure for EASD is approximately a factor of 4. Structural damage comprises approximately 30% of EADD, with the remainder coming from nonstructural assets (e.g., vehicles, roads), damage to contents and inventory, or direct losses tied to the duration of the restoration/reconstruction period (e.g., lost wages and sales, displacement costs).

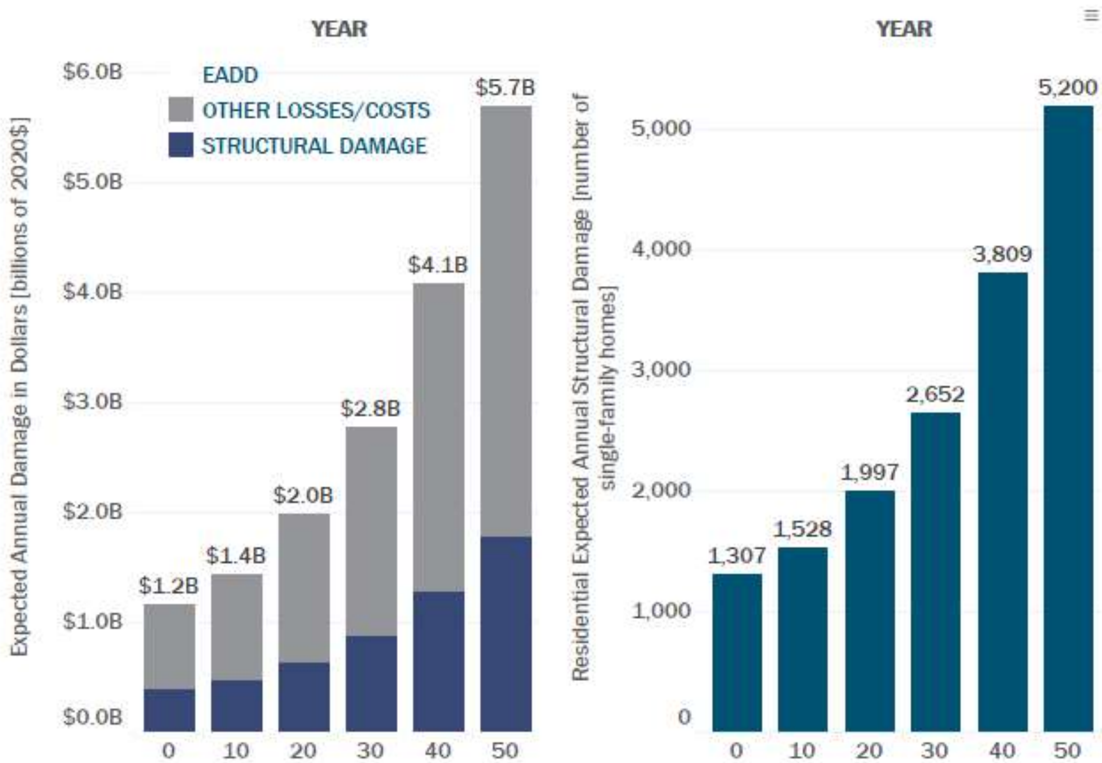

Figure 144. EADD (left) and residential EASD (right) in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

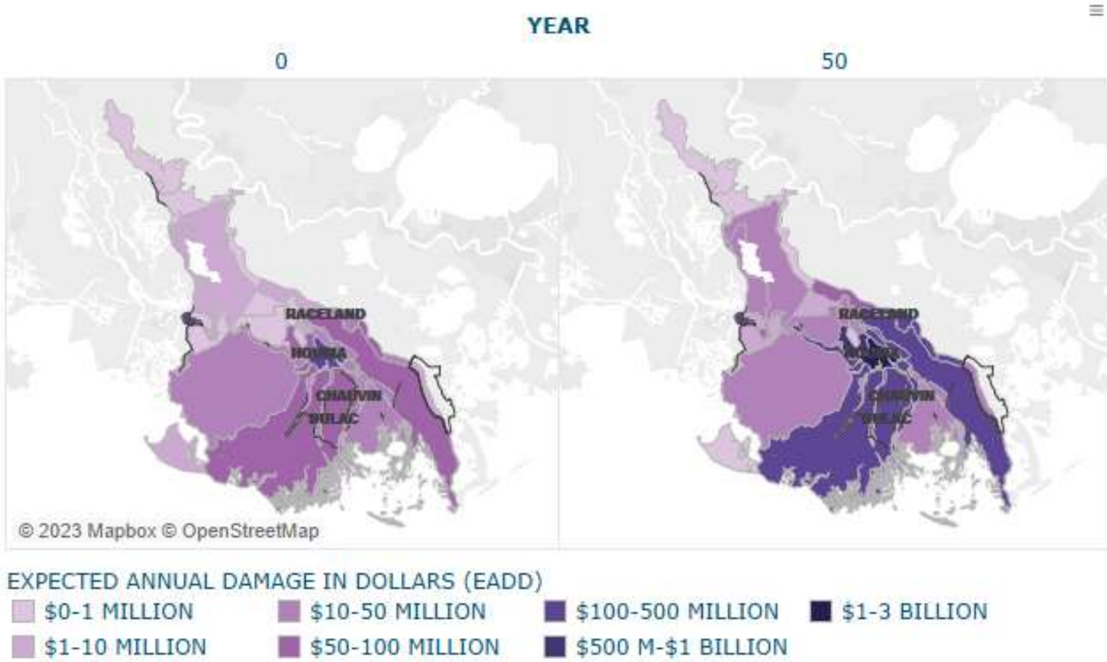

Figure 145. EADD by community in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Virtually all parts of the Terrebonne region are projected to see increased flood depth exceedances in 2070 relative to current conditions, so decreases in EADD over the same period are attributable to projected declines in exposed asset quantities and values tied in CLARA to decreasing populations. In the lower scenario, this occurs in Morgan City, lower Dularge, and Cocodrie, along with some small camps south of Bateman Island in unincorporated Terrebonne Parish (Figure 146).

The decline in Morgan City's projected EADD is in stark contrast with Houma (Figure 147). The two communities presently are estimated to have nearly identical EADD, but Houma's is projected to increase to $1.5 billion from a current baseline of about $200 million. Houma's population is likewise projected to decline in a FWOA scenario, but this effect is outweighed in dramatic fashion by the increase in hazard. Nearby communities Bayou Cane and Bayou Blue see even greater proportional rises in direct economic risk, contrasting with Montegut's much smaller increase from a similar baseline.

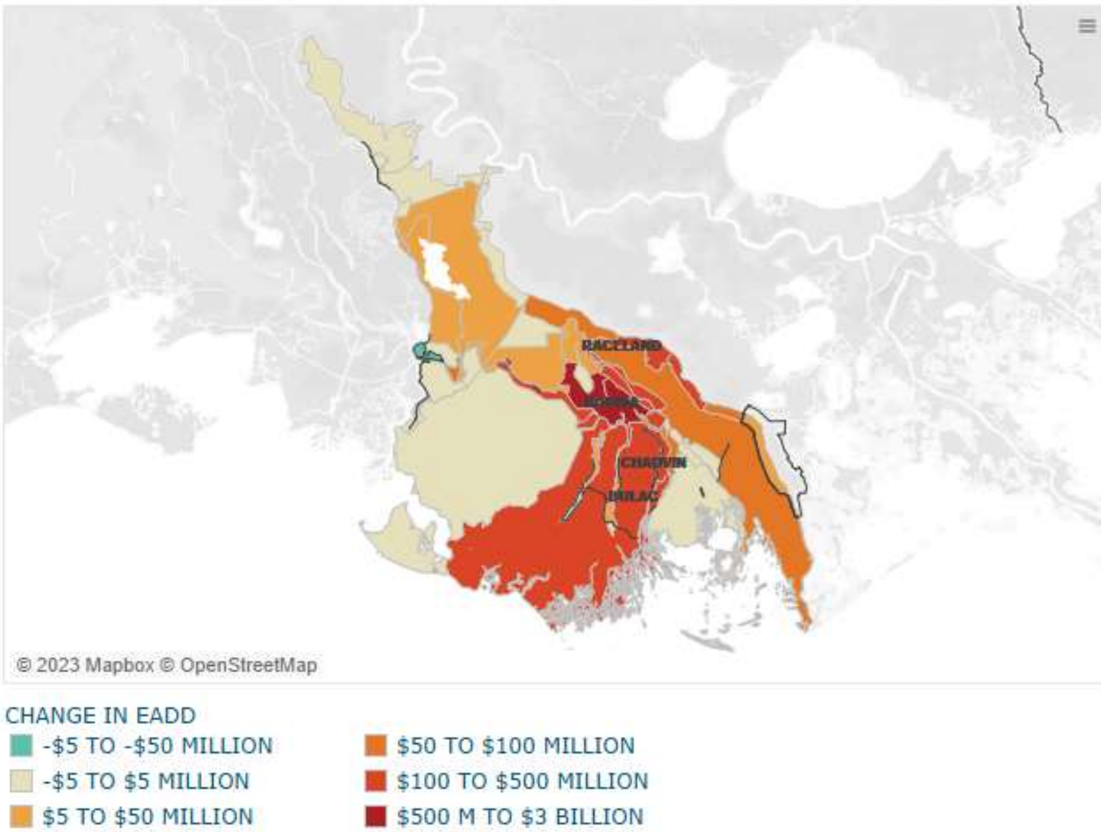

Figure 146. Change in expected annual damage by community in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile, Year 50 - Year 0.

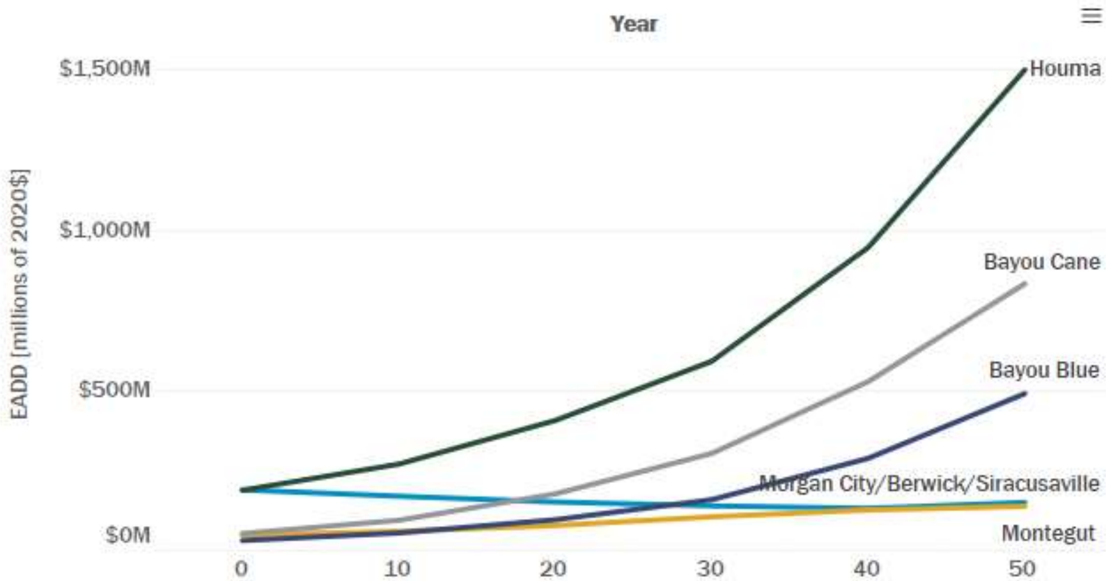

Figure 147. EADD in selected Terrebonne communities over the 50-year simulation period in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

HIGHER SCENARIO

Figure 148 shows that virtually 100% of single-family residential structures are exposed to flooding above first-floor elevations with a 2% AEP from Year 20 onward in communities south of Houma. Over 80% of such assets are exposed at the same return period in Houma itself, and the majority of such assets in Morgan City. Within the Larose to Golden Meadow Hurricane Protection Project and west of Bayou Lafourche, however, exposure remains much lower, at 8% in Year 40 and only 31% by Year 50.

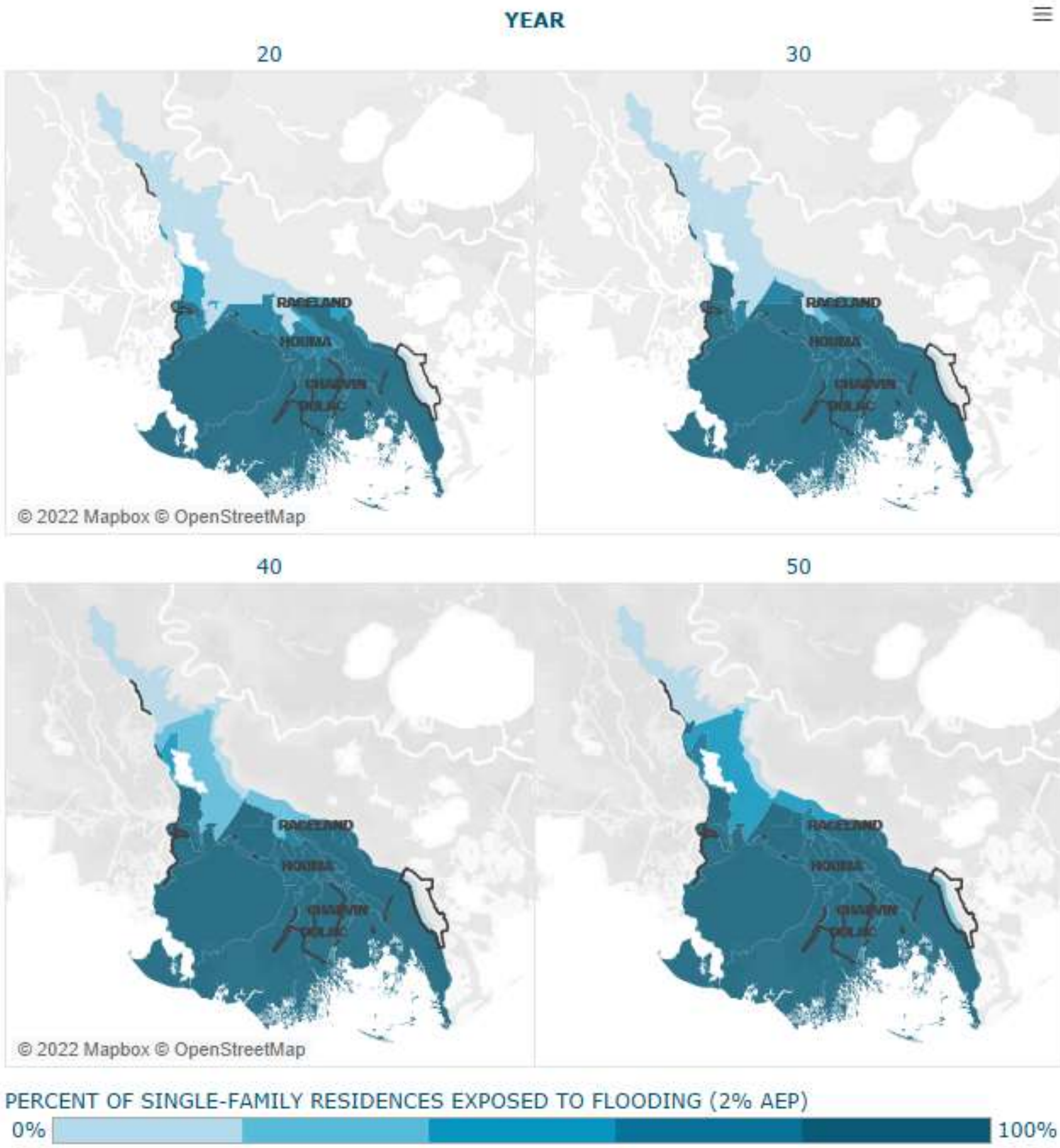

Figure 148. Residential structures exposed to 2% annual chance (1 in 50-year) flood depths above first floor elevation in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Among residential assets not currently exposed to flooding at a 2% AEP, only about one in four remain so over the entire planning horizon (Figure 149). Those that remain unexposed are primarily located in areas with enclosed levee systems (e.g., Morgan City, Galliano) or inland along Bayou Lafourche (e.g., Thibodaux).

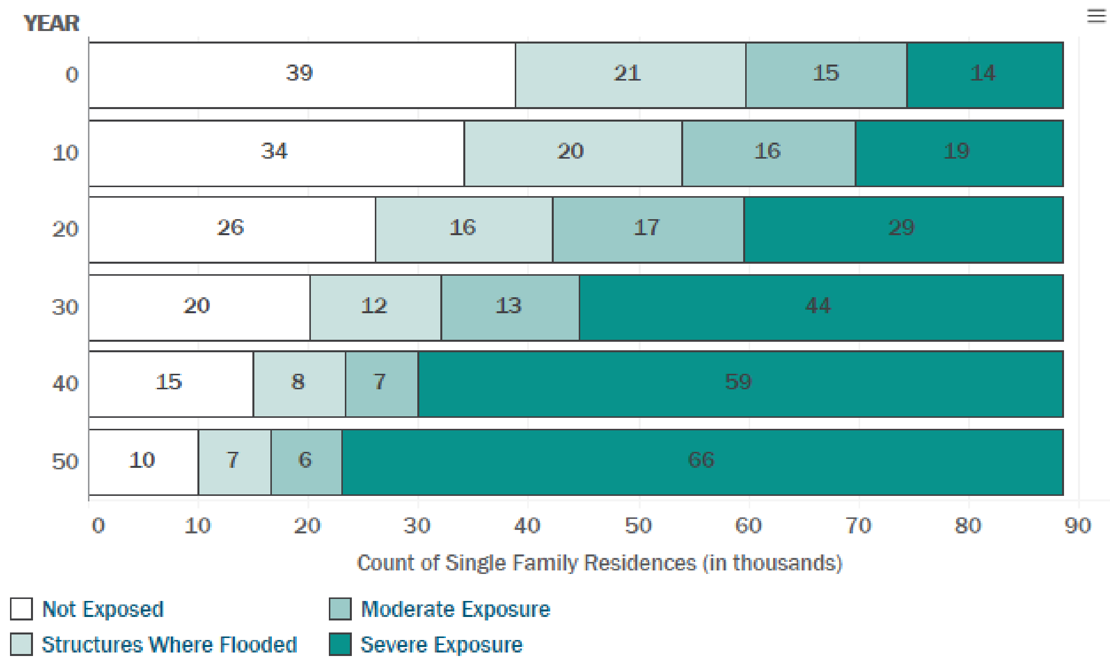

Figure 149. Residential structures exposed to 2% annual chance (1 in 50-year) flooding by exposure category in a higher scenario — IPET fragility, 50% pumping scenario, 50^{th} percentile.

The percentage of residential assets facing severe exposure in the higher scenario (i.e., flooding two feet or more above first-floor elevations) is projected to more than quadruple over the next 50 years, rising from 14% in 2020 to 66% by 2070 and leaving only 13% exposed but to a lesser degree. The increase in severe exposure is expected to accelerate over the next 40 years; the majority of this increase is projected over the first 30 years.

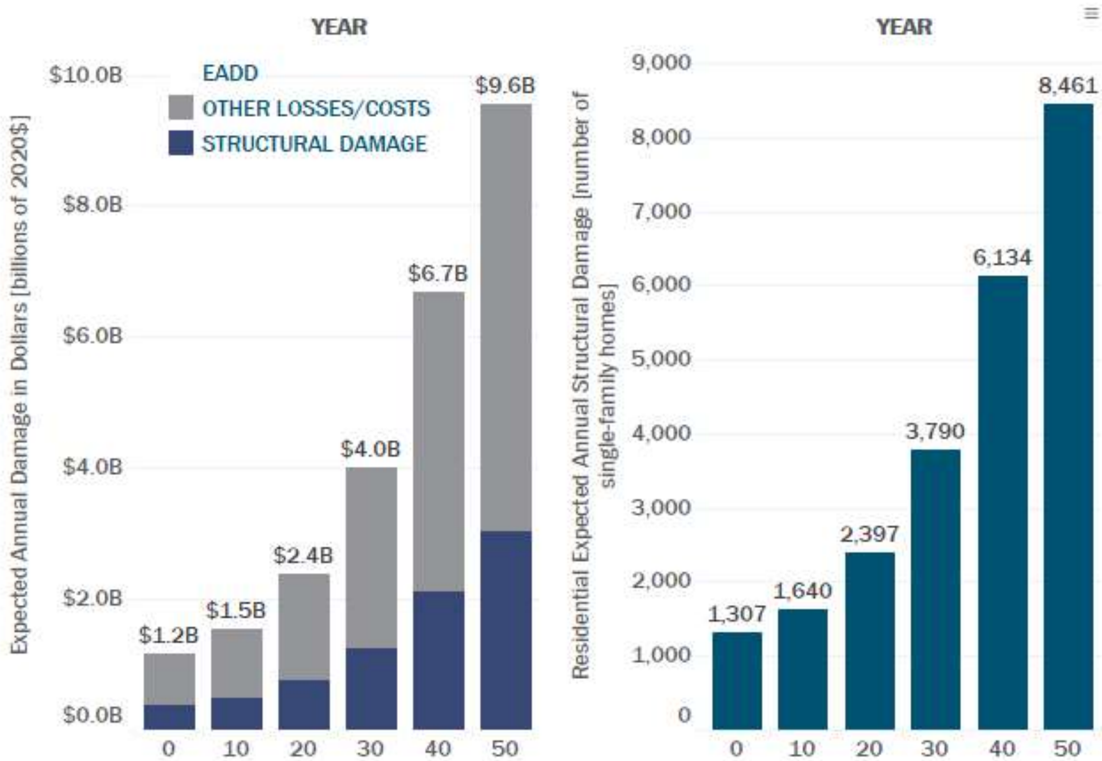

Figure 150. EADD (left) and residential EASD (right) in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Aggregated over the entire region, the temporal increases in EADD and EASD are highly correlated (Figure 150) and characterized by a sharp acceleration from Year 20 onwards. The total increase is greater proportionally for EADD, with Year 50 representing about 8 times the 2020 estimate; the corresponding figure for EASD is approximately a factor of 6.5. Structural damage comprises approximately 30% of EADD, with the remainder coming from nonstructural assets (e.g., vehicles, roads), damage to contents and inventory, or direct losses tied to the duration of the restoration/reconstruction period (e.g., lost wages and sales, displacement costs).

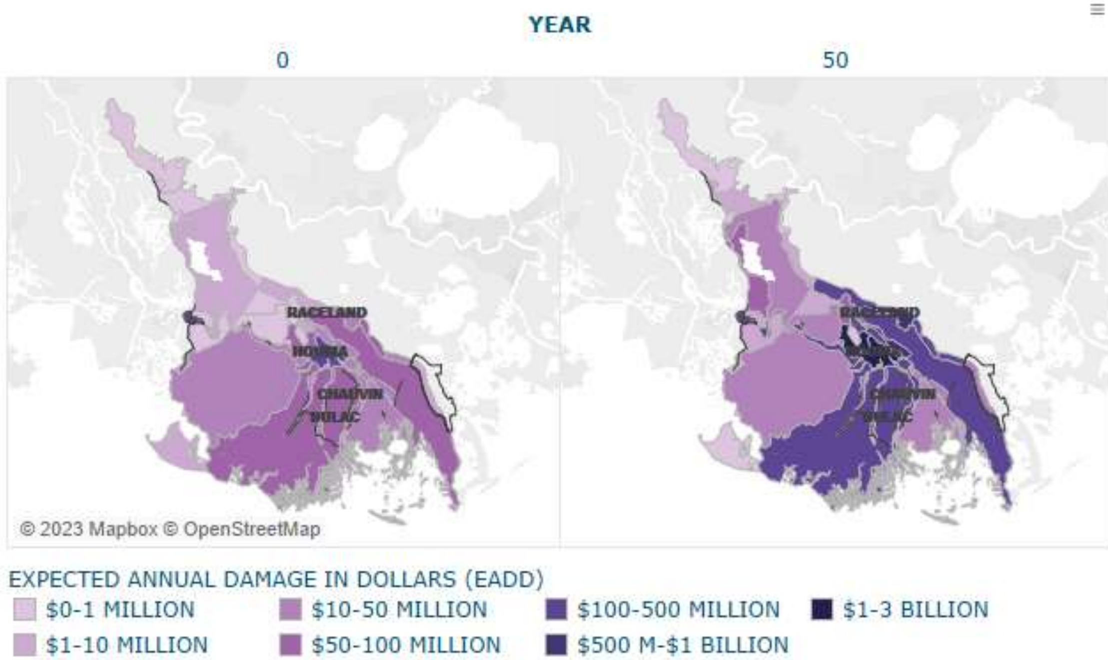

Figure 151. EADD by community in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Under current conditions, only Morgan City and Houma have an EADD over $100 million (Figure 151). By Year 50, however, this threshold is crossed by many of the master plan communities. Exceptions include Dularge and Dulac, Point-aux-Chenes and Isle de Jean Charles, and the poldered Cut Off/Galliano/Golden Meadow region. Many rural areas outside of identified communities also cross this threshold despite having many fewer assets projected in Year 50.

The increased flood depth exceedances in future years are mitigated in some areas by projected declines in population. As a result, we see a similar pattern in the higher scenario, that EADD declines from 2020 to 2070 in lower Dularge, Dulac, Cocodrie, and in undelimited parts of Terrebonne Parish south of Bateman Island (Figure 152). In the lower scenario, Morgan City also declined in EADD, but this is not projected to happen in the higher scenario, where the increase in environmental hazard outpaces the change in population.

This only occurs in later decades, however, as Morgan City's EADD in years 10 through 30 falls below current conditions (Figure 153). Patterns in the other selected communities shown in this figure are consistent with the lower scenario, though communities like Houma, Bayou Cane and Bayou Blue are projected to experience even more dramatic increases in risk in years 40 and 50.

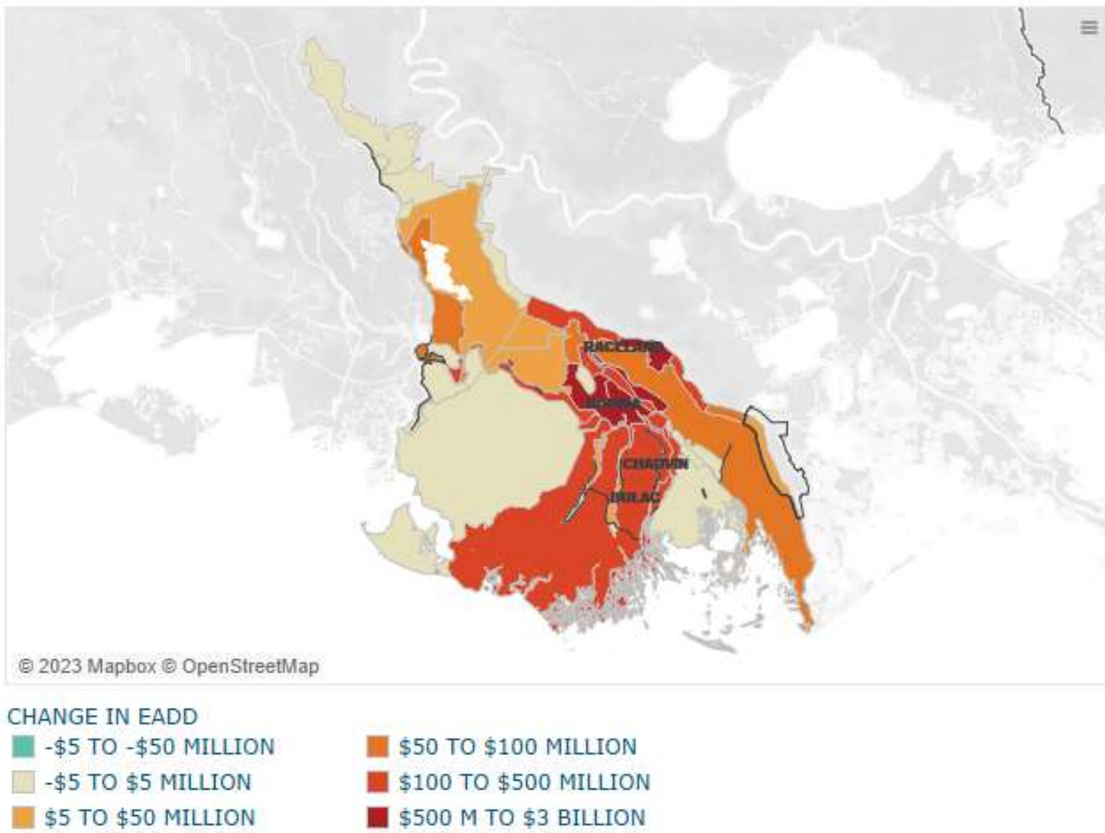

Figure 152. Change in expected annual damage by community in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile, Year 50 — Year 0.

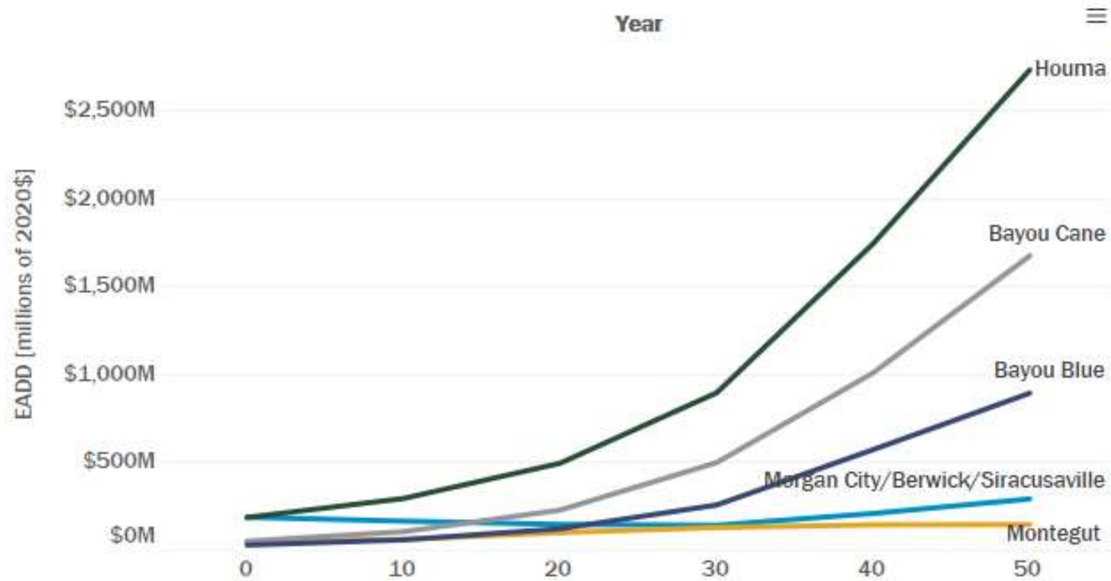

Figure 153. EADD in selected Terrebonne communities over the 50-year simulation period in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

DISCUSSION

Flood hazard in the Terrebonne region is projected to increase decade over decade, with some areas currently benefiting from elevated features experiencing sudden non-linear growth in flood depth exceedances at multiple return periods. The corresponding figures for direct economic damage are more complicated due to the confounding factor of expected population declines in many areas, particularly rural communities lacking federal levee systems.

Population change in already sparsely populated areas does little to stem the tide of increasing vulnerability when considering the Terrebonne region as a whole. EADD is projected to increase from $1.2 billion in 2020 to $5.7 billion and $9.6 billion in 2070 of the lower and higher scenarios, respectively. The corresponding increases in EASD to residential structures is from 1,307 in 2020 to 5,200 and 8,461 in 2070. For both metrics, more than half of the increase in risk occurs from 2050 to 2070. The majority of risk at the end of the planning period is concentrated in Houma and nearby communities Bayou Cane and Bayou Blue; in 2070 of the higher scenario, for example, they collectively represent $5.3 billion in EADD, a majority of the regional total of $9.6 billion.

5.0 CENTRAL COAST

5.1 DESCRIPTION

GEOGRAPHY

The Central Coast region is bounded on the west by Freshwater Bayou and the Freshwater Bayou Canal, from Abbeville to the Gulf. On the east, the region is bounded by Bayou Shaffer and the bank of the Lower Atchafalaya River to its mouth, then following the shoreline around Atchafalaya Bay to Point Au Fer. The region contains extensive coastal marshland, natural ridges, forests, and agricultural land (Figure 154). The primary crops grown include sugarcane, soybeans, and rice. Scattered throughout the region are a series of salt domes, subsurface vertical cylinders of salt marked by low surficial mounds. Major accumulations of oil and natural gas are associated with the salt domes in the region.

The region includes two coastal basins, the Atchafalaya and Teche-Vermilion, separated by the West Atchafalaya Basin Protection Levee. The Teche-Vermilion Basin is occupied by three large bays: East Cote Blanche Bay, West Cote Blanche Bay, and Vermilion Bay. Marsh Island, an uninhabited low-lying marshy island in Iberia Parish, separates these bays from the Gulf. As a result, the wetlands in the Teche-Vermilion Basin are primarily fresh, intermediate, and brackish with relatively few salt marshes.

The Atchafalaya Basin is home to the Atchafalaya Swamp, the largest river swamp in North America. This broad expanse of fresh marsh, bottomland hardwoods, cypress swamps, and open water supports highly productive fisheries and hunting grounds. The dominant landscape feature of the basin is the Atchafalaya Basin Floodway, a system of floodways comprised of the Morganza Floodway, the West Atchafalaya Floodway, and the Atchafalaya Basin Floodway. This floodway system is the largest such feature in North America. Major waterways in the basin include the Lower Atchafalaya River, Wax Lake Outlet, Atchafalaya Bay, the Atchafalaya River, and bayous Chene, Boeuf, and Black.

The Atchafalaya Basin is unique among Louisiana’s coastal basins in that it has a growing delta system with nearly stable wetlands. According to the USACE, sedimentation and the accretion of land at the mouth of the Atchafalaya River and Wax Lake Outlet have resulted in new land pushing out into the Gulf. The growth of these active river deltas is expected to continue, with anticipated land gains in excess of 600% over the existing acreage over the next 50 years.

Due to their high elevation relative to the surrounding landscape, the natural levees along the region’s rivers and bayous have historically served as the site of human settlement in the region. Most of this settlement is located north of the GIWW, along the Lower Atchafalaya River and Bayou Teche, stretching from Morgan City to New Iberia, where the geology transitions to a series of elevated Pleistocene prairie terraces. The development includes a combination of urban, suburban, and rural/agricultural development, with most high-density development occurring on the Pleistocene Terraces including communities such as Abbeville and New Iberia, part of the Lafayette metropolitan statistical area.

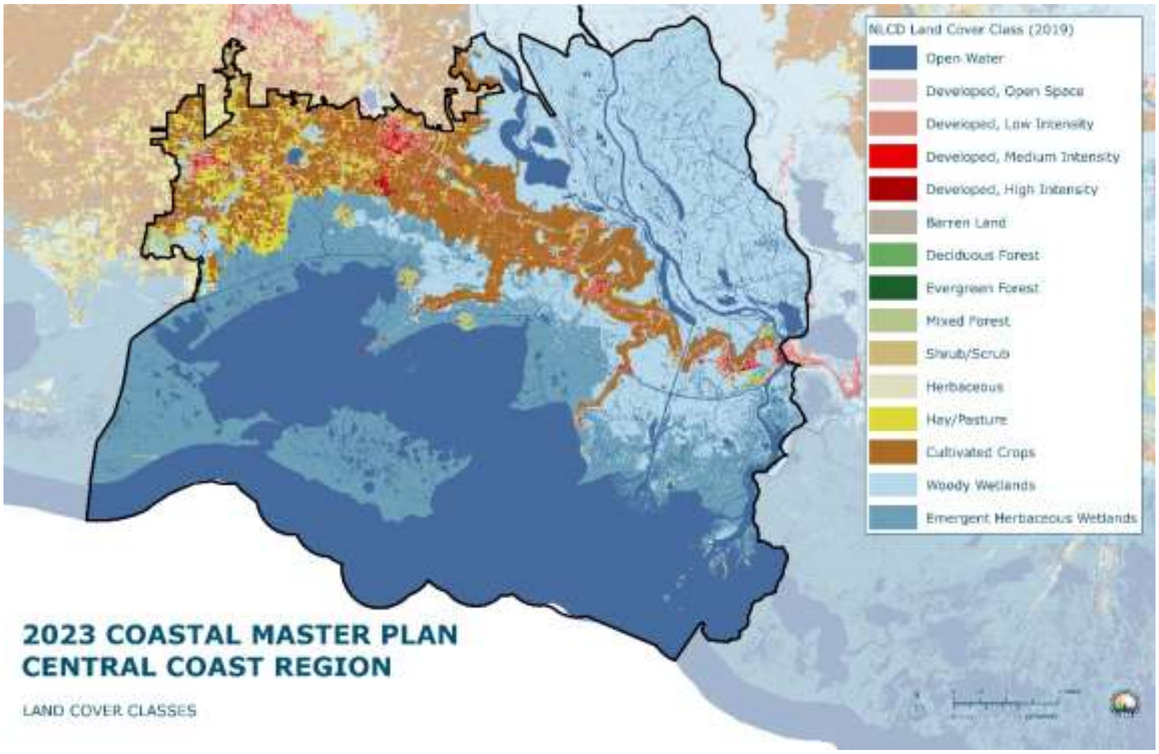

Figure 154. Land cover types in the Central Coast region.

STRUCTURAL PROTECTION

The natural levees of the bayous and rivers of the region as well as the elevated salt dome features that dot the area provide a degree of protection for the communities that are sited on them. This is true of the communities in the Teche-Vermilion Basin on the east of the Central Coast region. Communities in and around the Atchafalaya Basin, however, are more vulnerable to flooding, particularly riverine flooding from the Atchafalaya River and are therefore reliant upon additional structural protection.

The Atchafalaya Floodway is a major drainage system located within the Atchafalaya Basin on the eastern side of the Central Coast region (Figure 155). Water flow within the floodway is controlled by a series of levees, pumping stations, canals, and other constructed features designed to reduce risk and mitigate for economic flood damages in the basin. In 1963, USACE completed construction of the Old River Control Structure, a structure that restricts the flow of water from the Mississippi, Red, and Black rivers down the Atchafalaya River to 30% of the total flow, with the remaining 70% diverted annually to the Mississippi River. These values approximate the flow in the 1950s. A 1973 redesign of the Old

River Control Structure allows up to 50% of combined flow of the Mississippi, Red, and Black rivers to be diverted down the Atchafalaya during major floods and to minimize stress to the structures.

Today, several federally authorized levees and water control structures in the Atchafalaya Basin provide flood protection and include 10 pump stations, Calumet Floodgate East and West, Charenton Floodgate, Bayou Chene, and multiple barge gates at existing navigation channels. Flood risk reduction systems in the basin include a combination of protection levees, river levee, and ring levees. These include Southern West Atchafalaya River Levee, Southern West Atchafalaya Basin Protection Levee, Southern East Atchafalaya River Levee, levees west of Berwick, Bayou Sale levees, Avoca Island Levee, the Morgan City Back Levee and floodwall, and the Southern Pacific Railroad Levee.

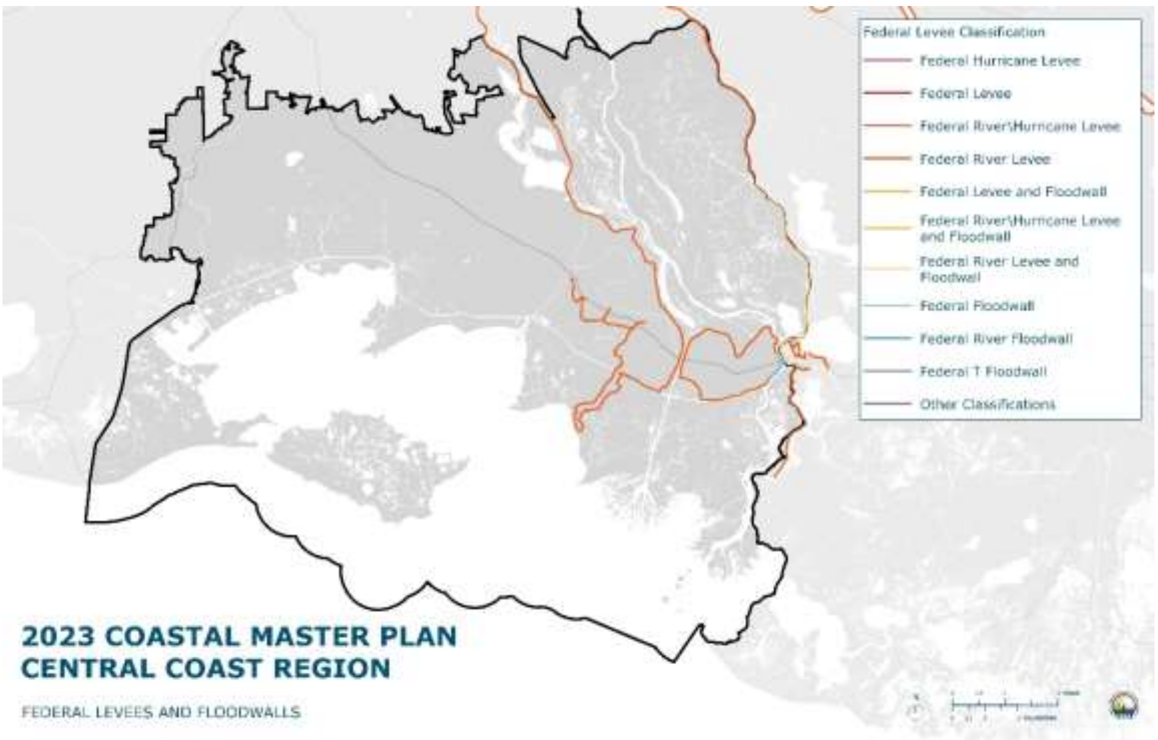

Figure 155. Structural protection in the Central Coast region.

POPULATION

The Central Coast region includes many of the population centers in St. Martin, St. Mary, and Iberia parishes, the majority of which are located along Bayou Teche. The GIWW serves as a dividing line in the Central Coast region with the majority of population centers located north of the waterway. The largest municipalities include Breaux Bridge and St. Martinville in St. Martin Parish; New Iberia, Jeanerette, Delcambre, and Loreauville in Iberia Parish; and Morgan City, Franklin, Patterson, Baldwin, and Berwick in St. Mary Parish (Figure 156). The region is also home to the only federally recognized

Indigenous tribe in coastal Louisiana, the Chitimacha Tribe of Louisiana. The tribe has sovereignty over a large portion of the community of Charenton in St. Mary Parish.

Most of the development in the Central Coast region is found in the fastlands along Bayou Teche and other waterways and incudes a combination of urban, suburban, and rural/agricultural development. Sugarcane is the dominant agricultural crop grown in the region along with timber, corn, rice, cotton, peppers, and dairy cattle. Other commercial activities in the region include commercial fishing and trapping, oil and gas production, and salt mining. Three large ports support these commercial activities and include the Port of Morgan City, Port of West St. Mary, and Port of Iberia.

The western portion of the region borders Vermilion and West Cote Blanche bays while the eastern portion borders Atchafalaya Bay. The region's proximity to the Gulf presents increased community vulnerability to tropical storm events. In recent years, communities in the Central Coast region have experienced adverse impacts resulting from repeated storm events, such as Hurricanes Rita, Ike, Gustav, and Barry. Despite the presence of Marsh Island and two accreting river deltas, some marsh areas in the region have been subject to localized wetland loss, including shoreline erosion and isolated interior marsh deterioration often resulting from the historical construction of navigation channels, oil and gas access canals, spoil banks, and levees.

Figure 156. Population density of communities comprising the Central Coast region.

The Central Coast region is racially and ethnically diverse, with several communities having percentages of minority residents well above the statewide averages (Table 11). The majority of the communities in the region, including Abbeville, Baldwin/Charenton, Franklin, Glencoe, Jeanerette, New Iberia, Patterson, and Sorrel have Black populations above the statewide average of 33%. Abbeville, Erath, Lydia, and New Iberia have similarly high proportions of Asian residents above the statewide average of 1.9%. Several communities also have a high proportion of Indigenous residents. The Chitimacha Tribe of Louisiana currently maintains a reservation adjacent to the town of Charenton. As a result, the percentage of Indigenous residents living in Baldwin/Charenton is greater than 12%, considerably higher than the statewide average of 0.8%.

Finally, the proportion of residents in poverty in several Central Coast communities is higher than the statewide average of 19.6%. This includes Abbeville, Erath, Franklin, Glencoe, Jeanerette, Lydia, Morgan City/Berwick/Siracusaville, New Iberia, and Sorrel.

Table 11. Demographics of Central Coast communities

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
ABBEVILLE	16,017	8,622	5,409	60	829	767	4,179
		53.8%	**33.8%**	**0.4%**	**5.2%**	**4.8%**	**23.7%**
BALDWIN/ CHARENTON	3,536	1,362	1,509	440	12	74	592
		38.5%	**42.7%**	**12.4%**	**0.3%**	**2.1%**	**16.8%**
CYPREMORT POINT	36	28	3	1	1	1	10
		77.8%	**8.3%**	**2.8%**	**2.8%**	**2.8%**	**20.8%**
DELCAMBRE	3,143	2,582	287	27	4	171	550
		82.2%	**9.1%**	**0.9%**	**0.1%**	**5.4%**	**17.0%**
ERATH	3,899	3,341	185	20	108	167	796
		85.7%	**4.7%**	**0.5%**	**2.8%**	**4.3%**	**19.8%**
FRANKLIN	8,289	3,274	4,301	86	45	365	1,659
		39.5%	**51.9%**	**1.0%**	**0.5%**	**4.4%**	**19.6%**
GLENCOE	133	14	112	0	0	5	39
		10.5%	**84.2%**	**0.0%**	**0.0%**	**3.8%**	**21.4%**
JEANERETTE	7,060	2,498	4,162	20	52	181	1,820
		35.4%	**59.0%**	**0.3%**	**0.7%**	**2.6%**	**25.7%**
LYDIA	2,493	1,566	608	14	85	148	1,813
		62.8%	**24.4%**	**0.6%**	**3.4%**	**5.9%**	**30.7%**
MORGAN CITY/ BERWICK/ SIRACUSAVILLE	21,270	14,107	3,718	238	245	2,416	7,792
		66.3%	**17.5%**	**1.1%**	**1.2%**	**11.4%**	**21.8%**
NEW IBERIA	45,767	24,270	16,417	191	1,224	2,740	9,950

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
		53.0%	**35.9%**	**0.4%**	**2.7%**	**6.0%**	**22.5%**
PATTERSON	8,326	4,516	2,909	109	61	444	1,478
		54.2%	**34.9%**	**1.3%**	**0.7%**	**5.3%**	**13.4%**
SORREL	875	484	332	4	1	31	188
		55.3%	**37.9%**	**0.5%**	**0.1%**	**3.5%**	**28.6%**

5.2 SUMMARY OF RISK

This section summarizes the simulation modeling results projecting coastal flood risk and damage for the Central Coast Region over a 50-year period in a FWOA. This includes projected storm surge and wave heights, flood depths, exposure of single-family residences, and flood damage. Model simulations for the region show increases in surge that are directly related to SLR. In addition, SLR and deepening bathymetry are predicted to allow this surge to penetrate further inland. However, the Atchafalaya River and Wax Lake Outlet deltas are expected to continue to build land resulting in reduced wave heights near these locations. Predicted damages in the region are related to both population density and degree of structural protection. Storm 372 is used to describe impacts within this basin. Storm 372 has a perpendicular track to the coast and makes landfall near White Lake. Surge is pushed against the levees throughout the Central Coast.

STORM SURGE AND WAVES

In the latter half of the 50-year period of analysis, the ICM shows decreases in elevation in the Central Coast region, except near the Atchafalaya River and Wax Lake Outlet deltas which are expected to continue to build land. ADCIRC simulations for the region show increases in surge generally related to SLR. The decrease in frictional resistance and deepening bathymetry resulting from the decreased elevation levels will allow surge to penetrate further inland. Under both environmental scenarios, areas like Marsh Island are expected to provide less of an impediment to surge, allowing more inundation in the locations around East Cote Blanche Bay, West Cote Blanche Bay, and Vermilion Bay. Wave heights are also expected to increase as a function of water depth; however, immediately adjacent to the Atchafalaya River and Wax Lake Outlet deltas, wave heights may decrease in response to the increased bathymetric elevations.

In Year 30 and Year 50 under the lower environmental scenario, the modeled storm is expected to inundate the southern portion of the Berwick polder and Franklin. Under current conditions, this modeled storm would not be expected to flood Berwick, and flood depths in Franklin would be much smaller. Similar results were found using the higher environmental scenario, with surge increasing related to SLR and decreases in frictional resistance and deepening bathymetry allowing this surge to penetrate further inland. By Year 50 in the higher scenario, the Berwick polder is almost fully inundated during this modeled event.

FLOOD DEPTH AND DAMAGE

CLARA simulations for the Central Coast region show increases in both the extent and depth of flooding over the 50-year period of analysis. These increases are generally linear in both lower and higher scenarios. The areas around Vermilion Bay, West Cote Blanche Bay, and Marsh Island always have larger flood depths than other areas in the Central Coast region. Much of this area is unpopulated and unprotected. However, it is notable that flood depths are expected to encroach northward to farmlands and populated communities along Bayou Teche, such as New Iberia and Erath. These communities have the greatest increase of flood depths over time across a range of return periods.

In the protected areas of the Atchafalaya Basin, including areas around Morgan City, CLARA simulations find lower flood depths than other parts of the region over time. This holds true under both environmental scenarios. Other protected areas, both to the north and south of Morgan City protected by the Bayou Benoit Levee are similarly not expected to experience a large amount of flooding, even under the higher environmental scenario. This is likely due to the 2023 Coastal Master Plan's assumptions about the maintenance and improvements of levee systems. An exception to this is at the northern end of Sale Levee System, where flooding and overtopping is expected to occur in communities such as Centerville, Calumet, and Garden City even though they are protected. In Year 50, this flooding extends to Patterson to the west of Morgan City. Results suggest that the Atchafalaya Basin Spillway Levees may not be able to protect these communities over time.

Matching the results of the flood depth models, CLARA simulations show economic damage in the Central Coast region increasing linearly in the early decades of the 50-year period of analysis and accelerating in the last decade under the lower scenario and in the last two decades under the higher scenario (Figure 157). This is likely due to the different assumptions of SLR rate in the two scenarios. The spatial pattern of structural assets exposure follows the flood depths results in both scenarios: the unprotected communities with substantial exposure are largely located in the southern half of the region on the north shore of Vermilion Bay and West Cote Blanche Bay. Under both environmental scenarios, over half of communities are anticipated to face exposure to flooding through a range of return periods. In total, CLARA results show that 74% of the communities examined will be flooded by the modeled storm in Year 50 under the higher environmental scenario. The flooding is tied to the rising sea levels and land subsidence in the coastal marsh areas of the region.

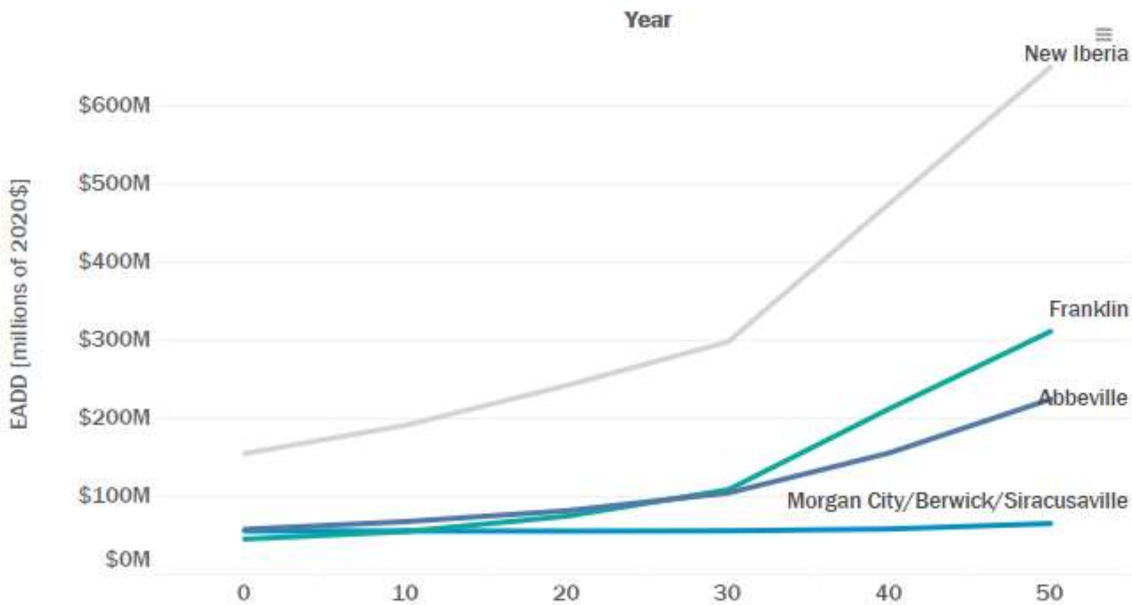

Figure 157. EADD in selected Central Coast region communities over the 50-year simulation period under the higher scenario.

The more densely populated communities in the region are expected to experience higher levels of economic damage. Today, for example, New Iberia, which is part of the Lafayette metropolitan statistical area, would be expected to suffer $100 million in annual damages from the modeled storm under both environmental scenarios. Over the 50-year simulation period, this is expected to increase by over $100 million. Similar numbers were found for Abbeville, another community in the Lafayette metropolitan statistical area. CLARA simulations for the leveed community of Franklin, in the Atchafalaya Basin, show large increases in annual damages over the period of analysis. In contrast, unincorporated locations outside the levees shows declining damage levels under both environmental scenarios. This decline is likely due to an expected decrease in population in these unprotected areas over time.

5.3 STORM SURGE AND WAVES RESULTS

The initial conditions landscape is modified by the spin up period of the ICM. Topography and bathymetry are shown in Figure 158. Additionally, initial conditions land use was interpolated to the model to construct Manning's n (Figure 159), directional wind reduction (Figure 160), and surface canopy coefficients (Figure 161). Updated data is interpolated to the ADCIRC model from the ICM every 10 years. This section shows how the model changes in Year 30 and Year 50 and the associated simulation results.

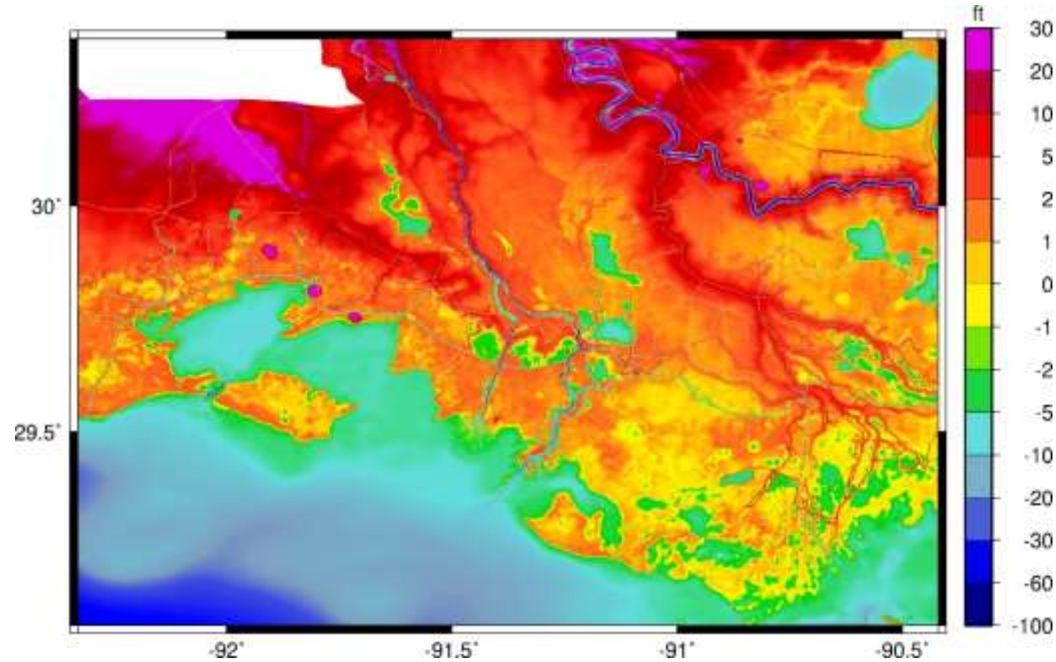

Figure 158. Topography and bathymetry (feet, NAVD88) in ADCIRC at Year 0.

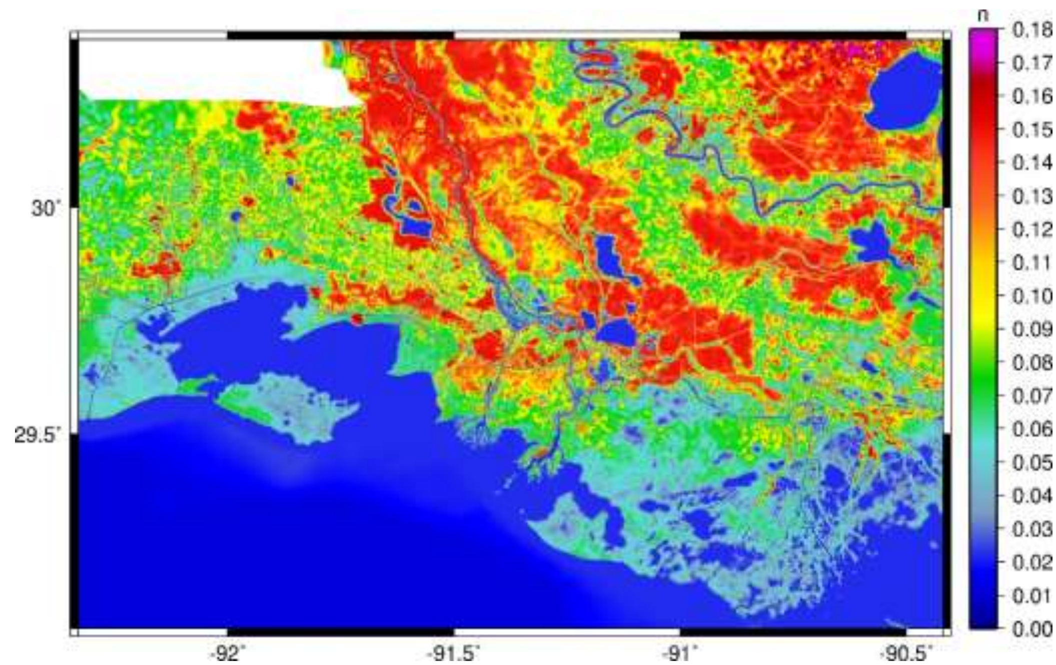

Figure 159. Manning’s n coefficient in ADCIRC at Year 0.

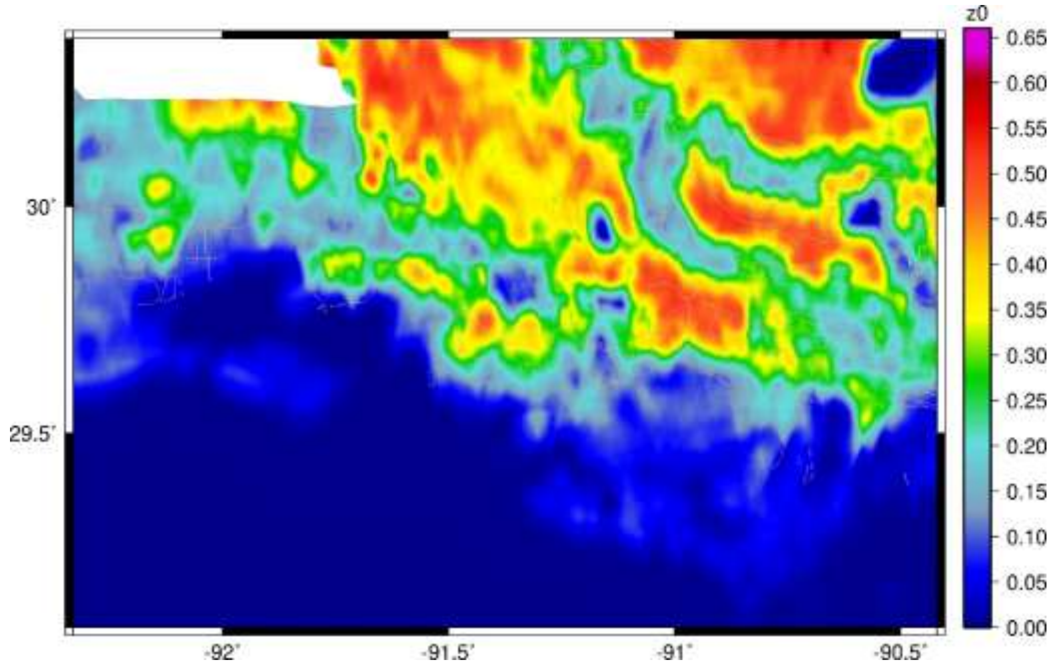

Figure 160. Directional wind reduction coefficient for a wind blowing from the south in ADCIRC at Year 0.

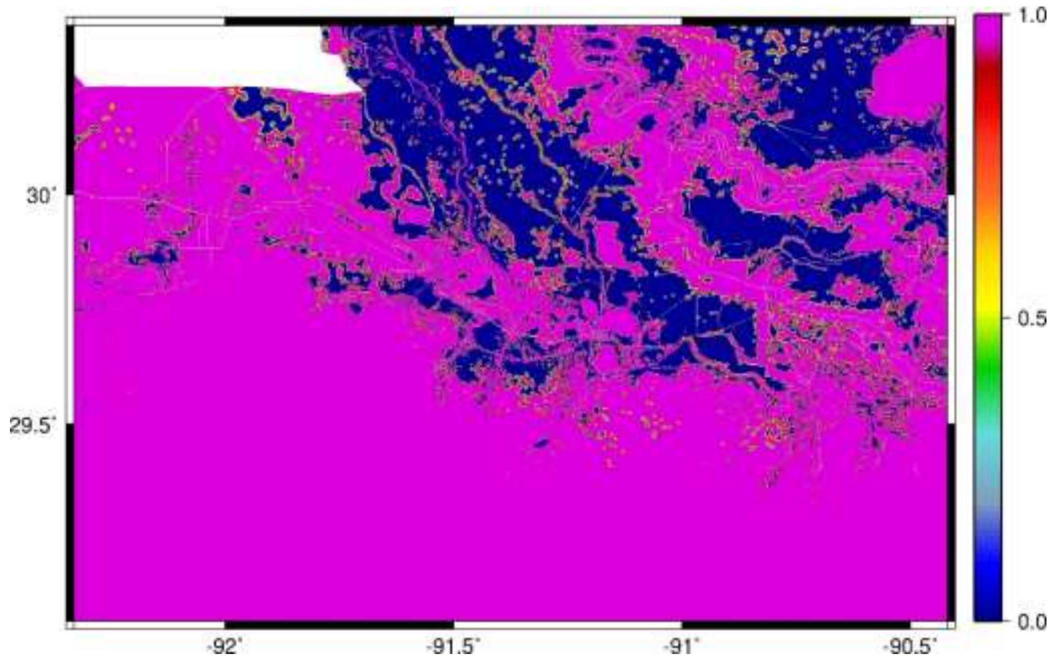

Figure 161. Surface canopy coefficient in ADCIRC at Year 0.

Storm 372 is used to describe impacts within this basin. Storm 372 has a perpendicular track to the coast and makes landfall near White Lake. Surge is pushed against the levees throughout the Central Coast. The peak surge elevation and peak wave height in Year 0 for Storm 372 is shown in Figure 162 and Figure 163.

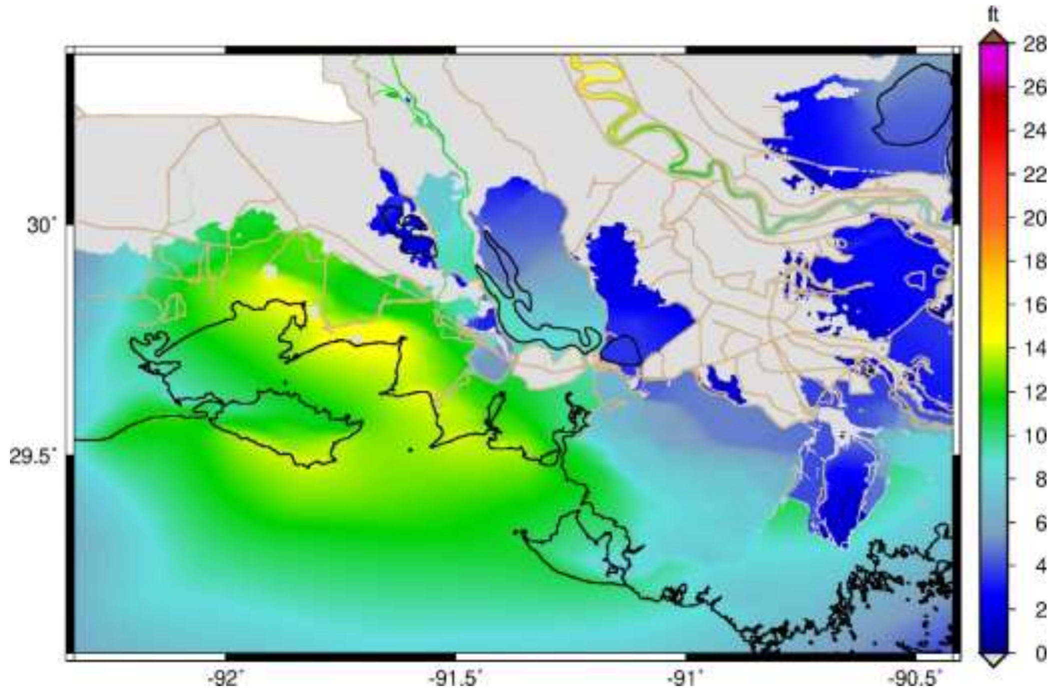

Figure 162. Peak water surface elevation for Storm 372 simulated in Year 0.

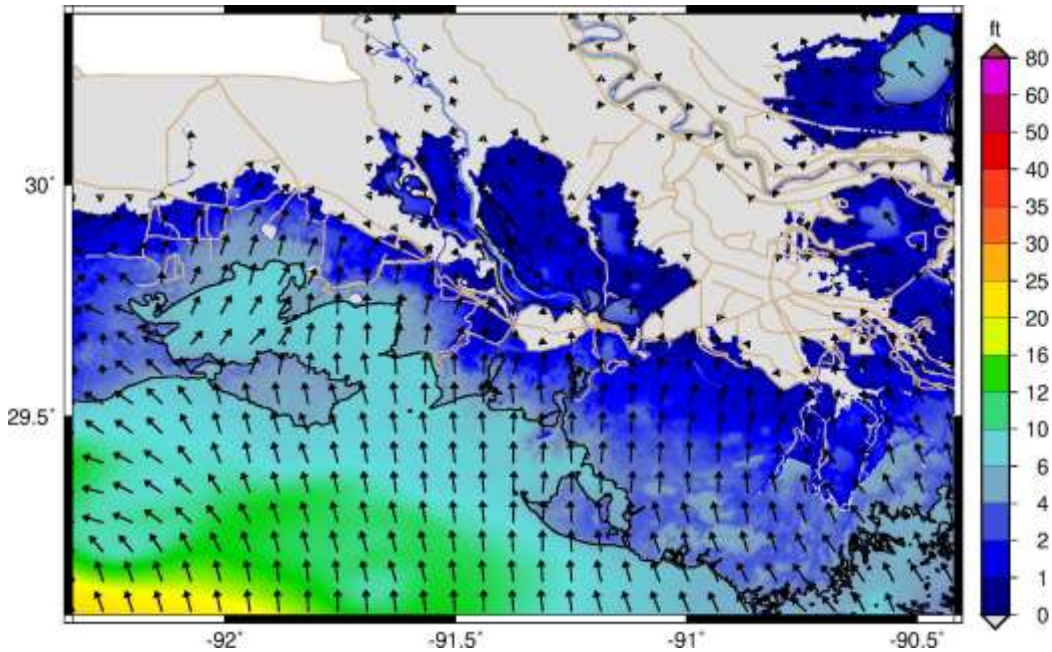

Figure 163. Peak wave height (feet) for Storm 372 in Year 0.

LOWER SCENARIO

In Year 30 and Year 50, the topographic elevations (Figure 164 and Figure 167) provided by the ICM generally show decreases in elevation except near the Atchafalaya River and Wax Lake Outlet deltas, which build land. Frictional coefficients (Figure 165, Figure 166, Figure 168, and Figure 169) generally decrease throughout the region, even with land building in the Atchafalaya Basin. Additional details about the changes in topography, bathymetry, and land use characteristics can be found in White et al. (2023).

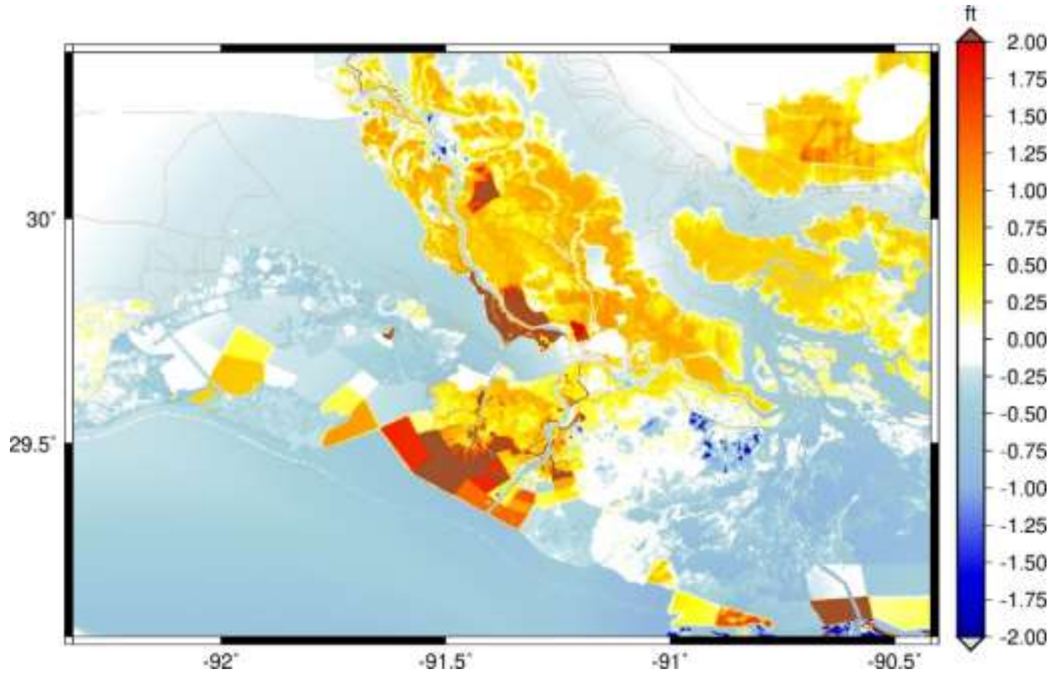

Figure 164. Change in topography and bathymetry in ADCIRC in the lower scenario for Year 30.

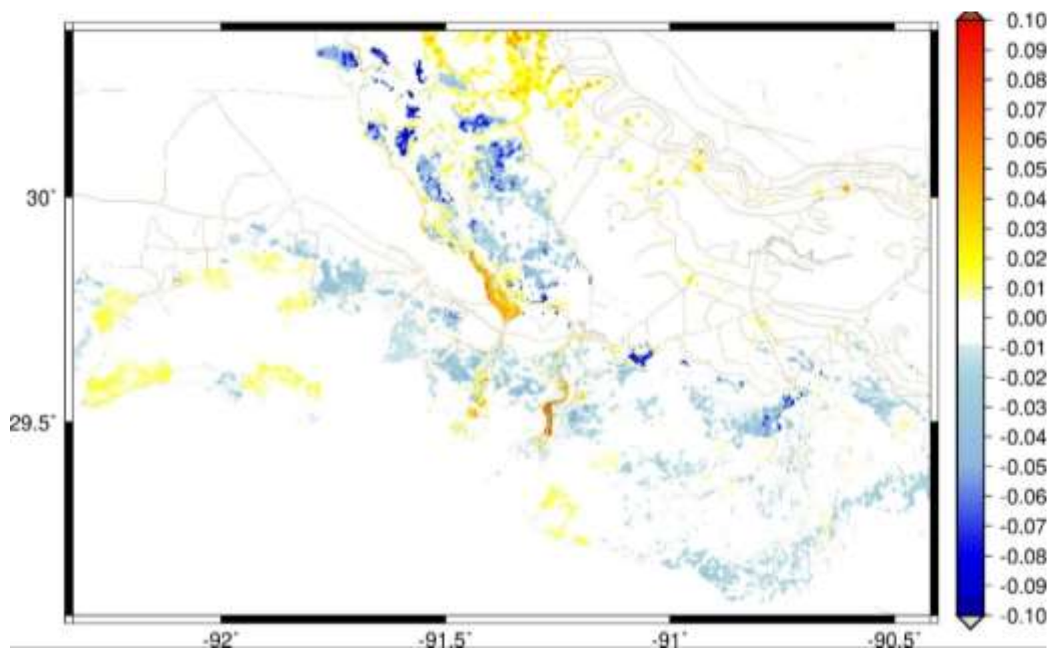

Figure 165. Change in Manning's n in ADCIRC in the lower scenario for Year 30.

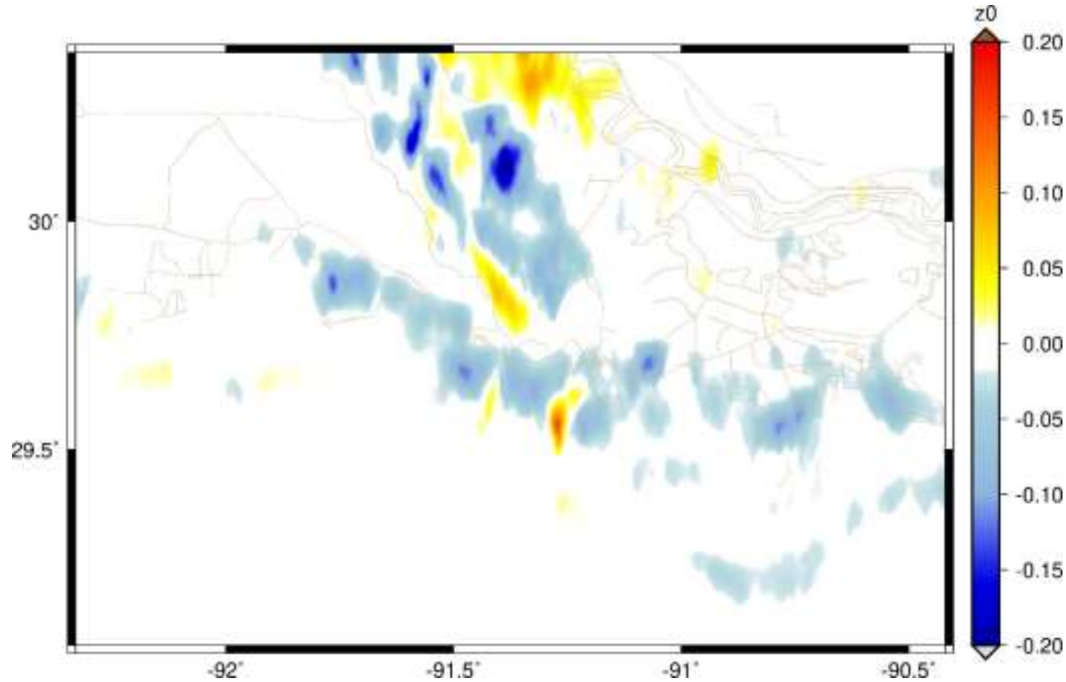

Figure 166. Change in directional wind reduction in ADCIRC in the lower scenario for Year 30.

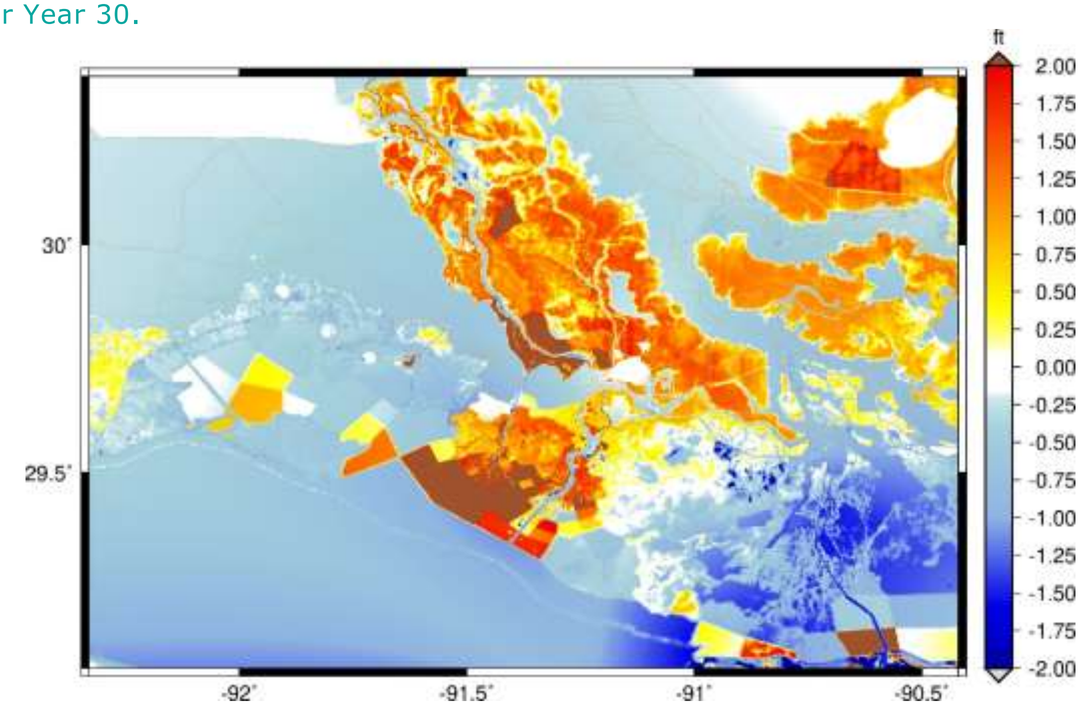

Figure 167. Change in topography and bathymetry in ADCIRC in the lower scenario for Year 50.

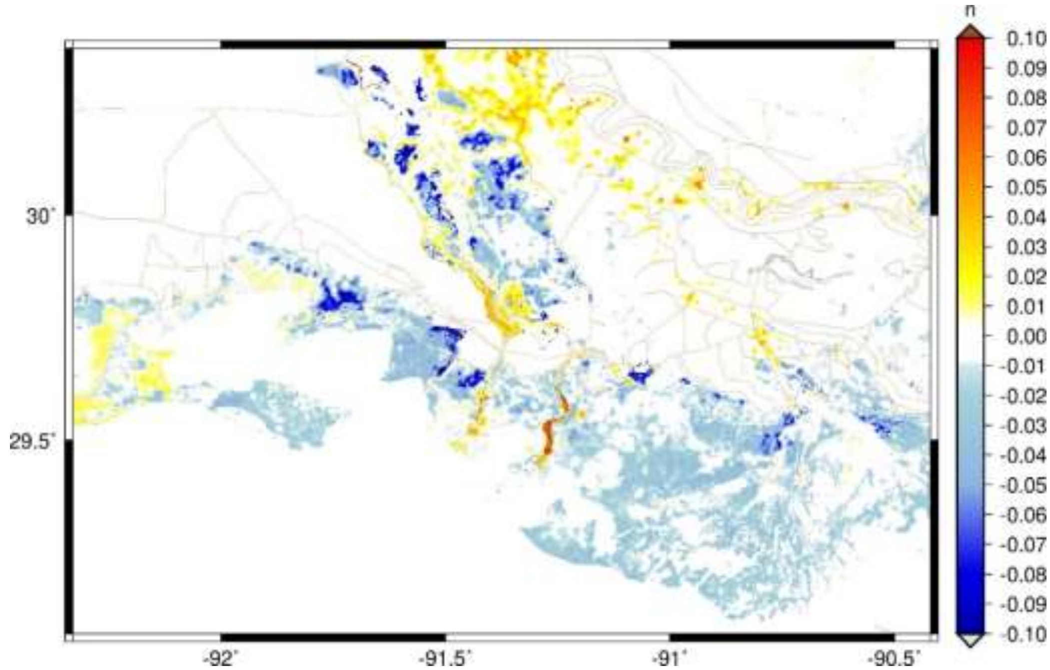

Figure 168. Change in Manning's n in ADCIRC in the lower scenario for Year 50.

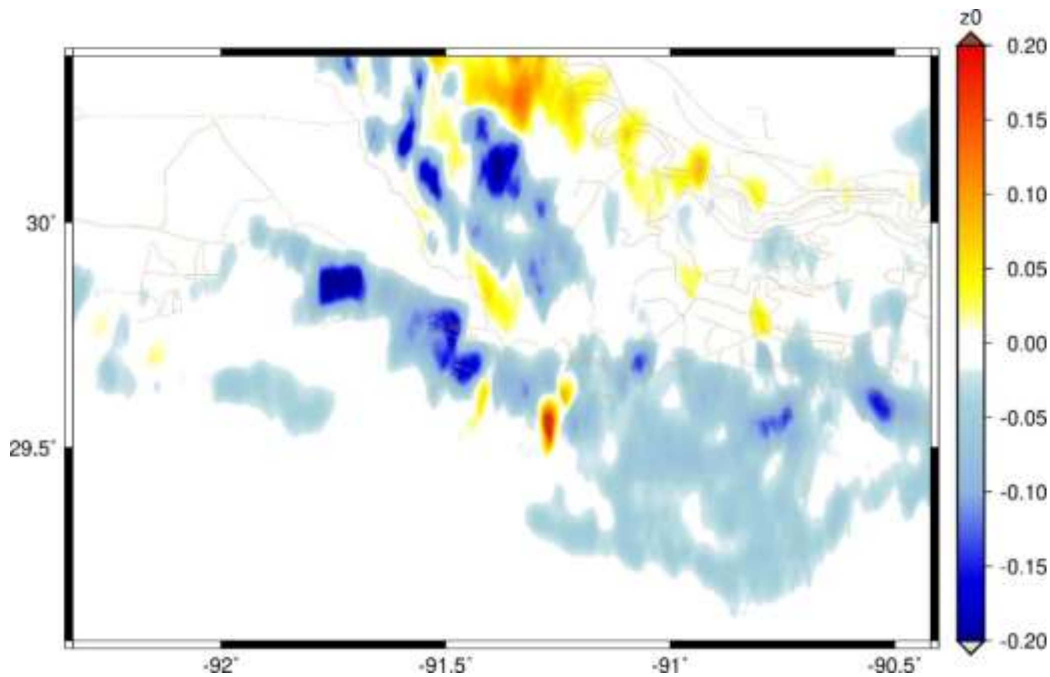

Figure 169. Change in directional wind reduction in ADCIRC in the lower scenario for Year 50.

The Central Coast area shows increases in surge generally related to SLR, though the decrease in frictional resistance and deepening bathymetry allow surge to penetrate further inland. Areas like Marsh Island now provide less of an impediment to surge as it inundates Vermilion Bay (Figure 170, Figure 172). Wave heights increase as a function of water depth; however, immediately adjacent to the deltas, wave heights decrease in response to the increased bathymetric elevations (Figure 171, Figure 173). In both Year 30 and Year 50, Storm 372 inundates the southern portion of the Berwick polder and Franklin where Berwick had not been inundated in Year 0 and Franklin which had flooded, but at a much smaller depth.

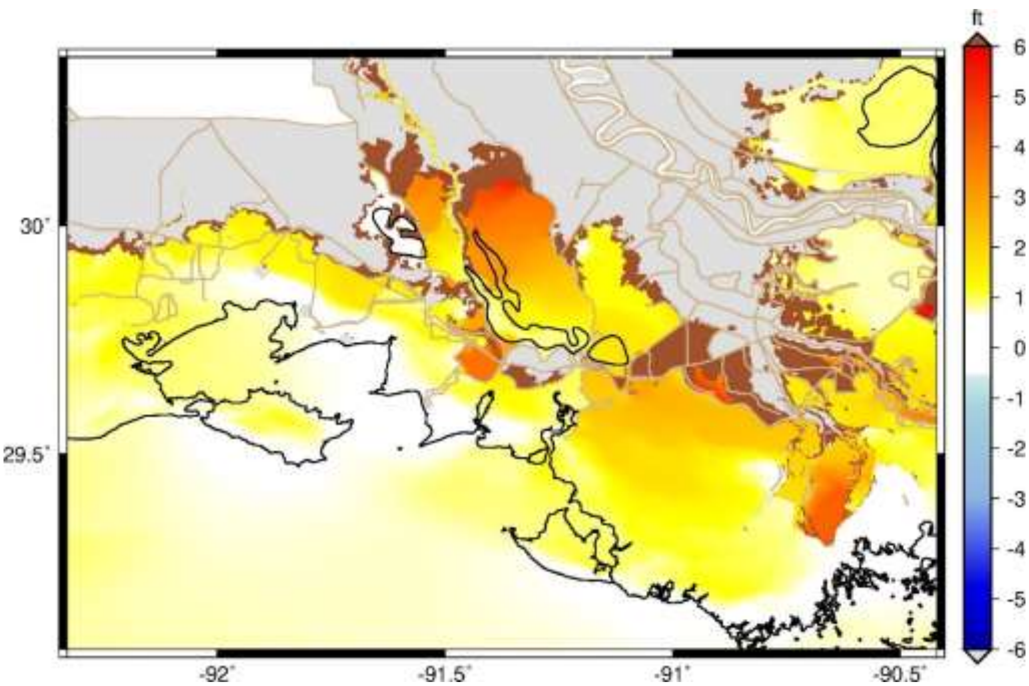

Figure 170. Change in peak water surface elevation between Year 30 and Year 0 in the lower scenario.

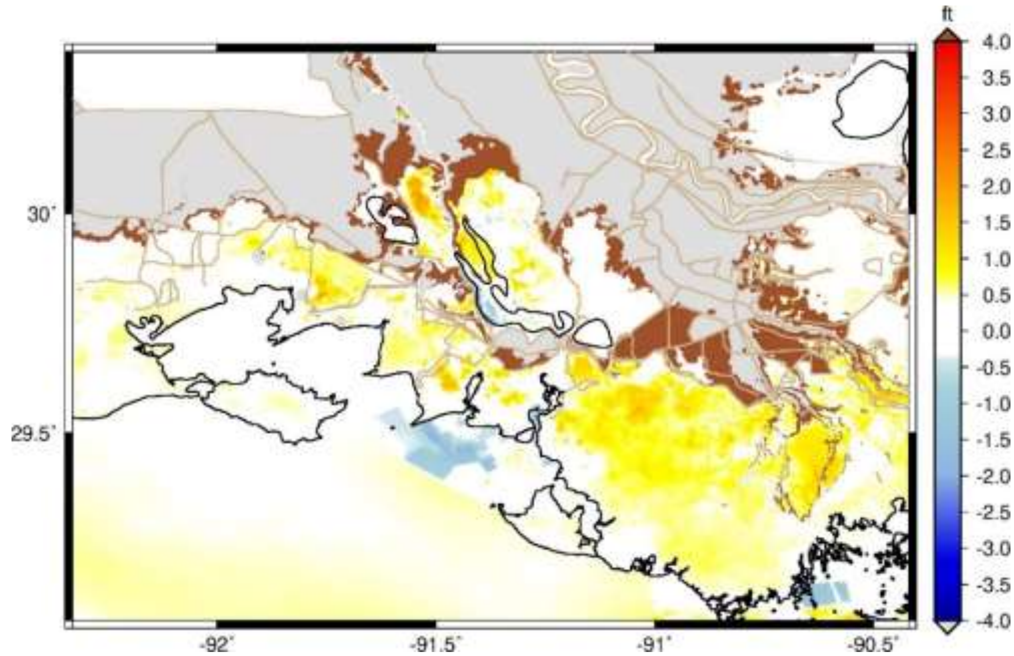

Figure 171. Change in peak wave height between Year 30 and Year 0 in the lower scenario.

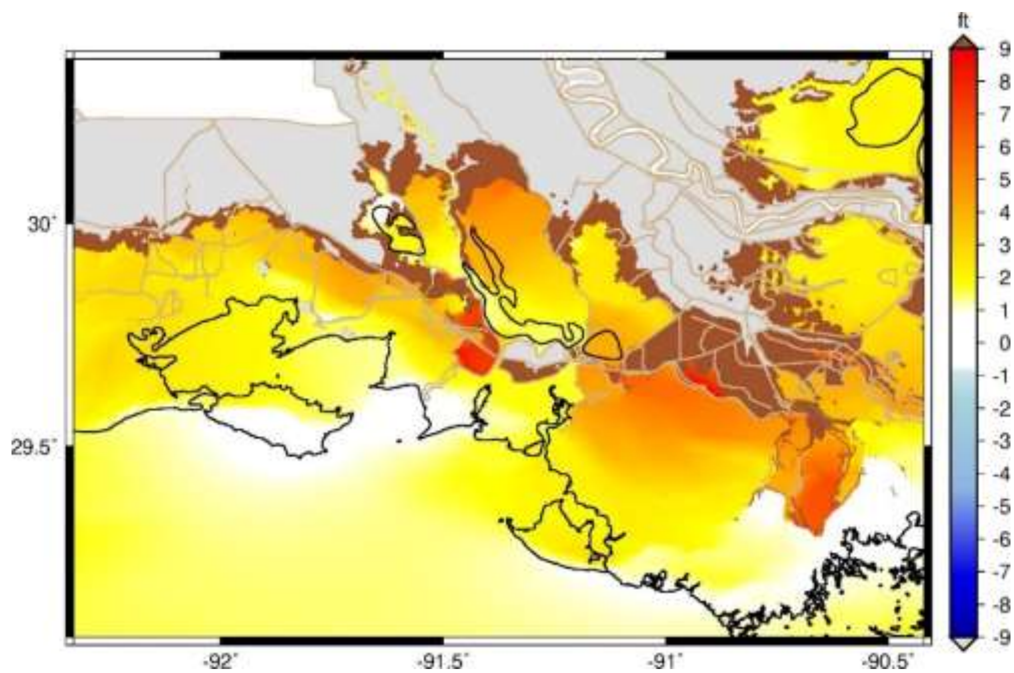

Figure 172. Change in peak water surface elevation between Year 50 and Year 0 in the lower scenario.

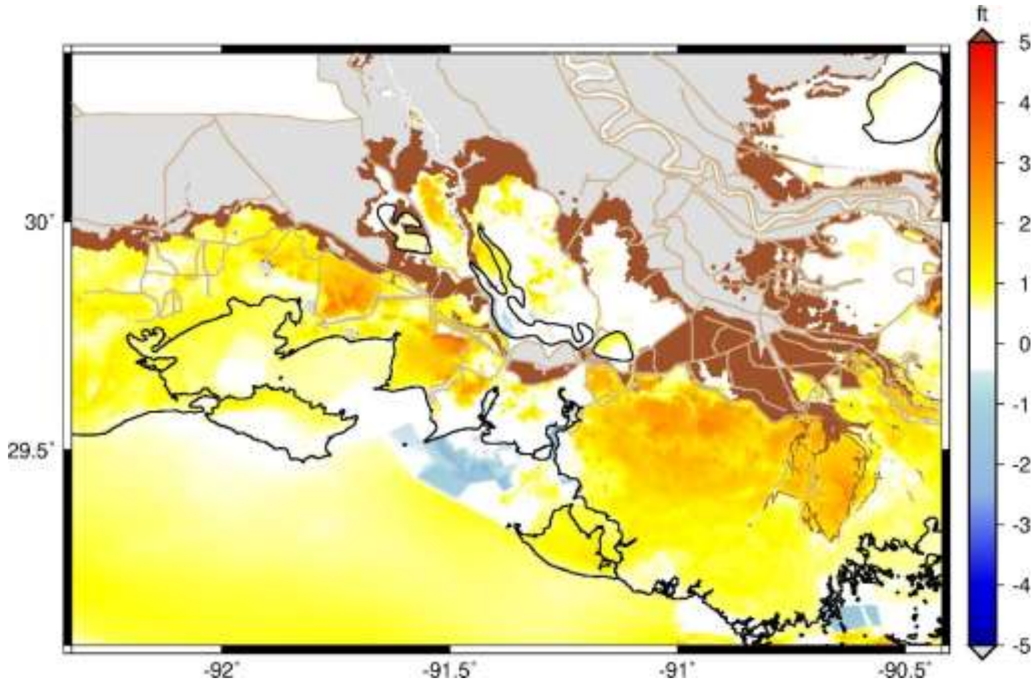

Figure 173. Change in peak wave height between Year 50 and Year 0 in the lower scenario.

HIGHER SCENARIO

In Year 30 and Year 50, the topographic elevations (Figure 174 and Figure 177) provided by the ICM generally shows decreases in elevation except near the Atchafalaya River and Wax Lake Outlet deltas, which build land. Frictional coefficients (Figure 175, Figure 176, Figure 178, and Figure 179) generally decrease throughout the region, even with land building in the Atchafalaya Basin. Additional details about the changes in topography, bathymetry, and land use characteristics can be found in White et al. (2023).

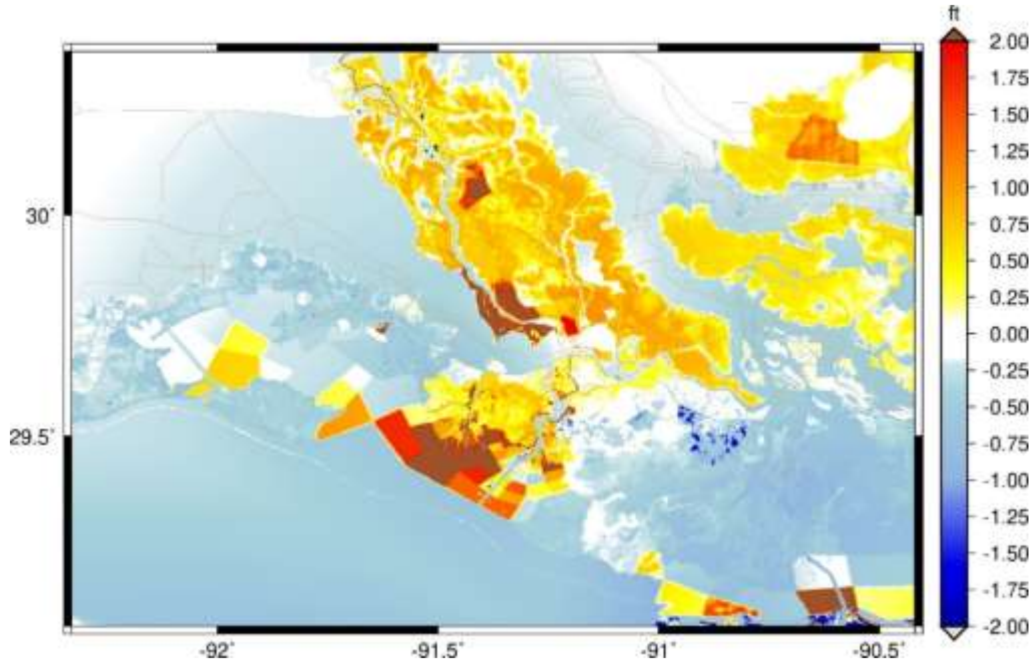

Figure 174. Change in topography and bathymetry in ADCIRC in the higher scenario for Year 30.

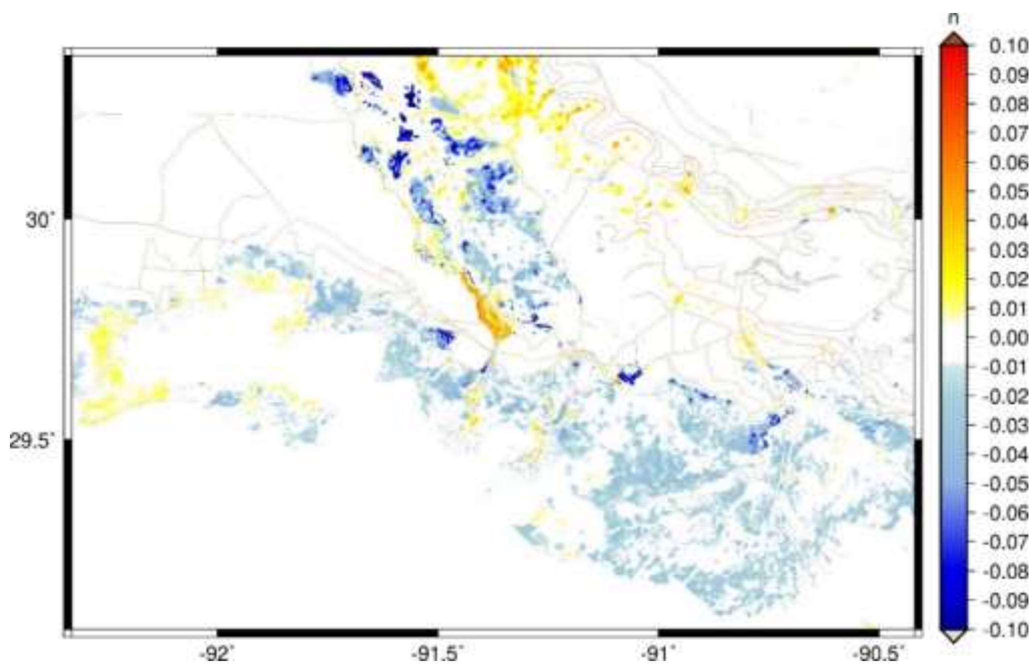

Figure 175. Change in Manning's n in ADCIRC in the higher scenario for Year 30.

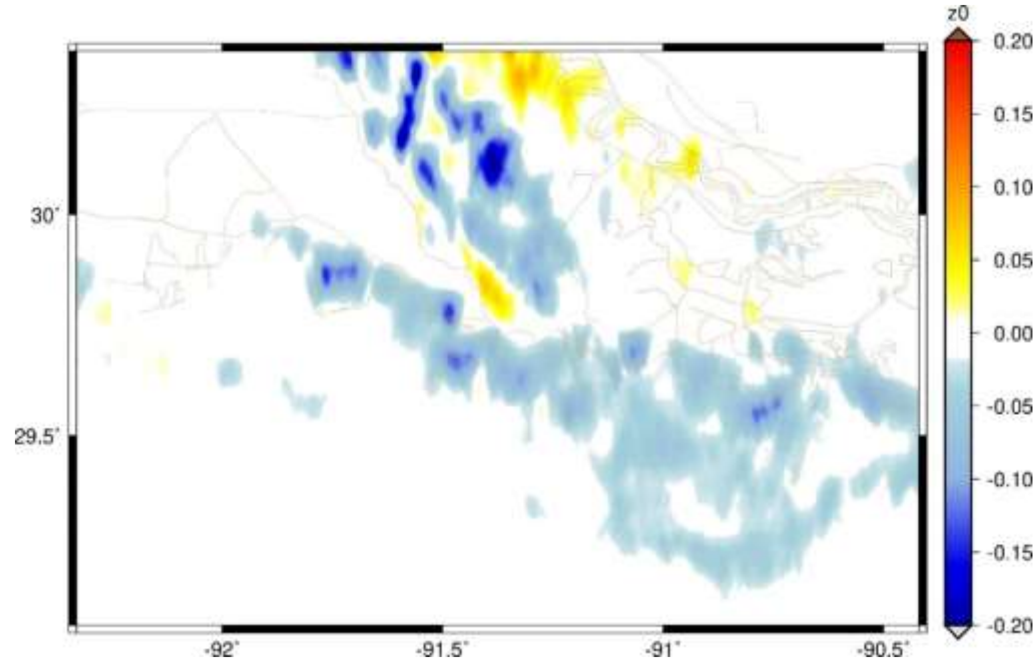

Figure 176. Change in directional wind reduction in ADCIRC in the higher scenario for Year 30.

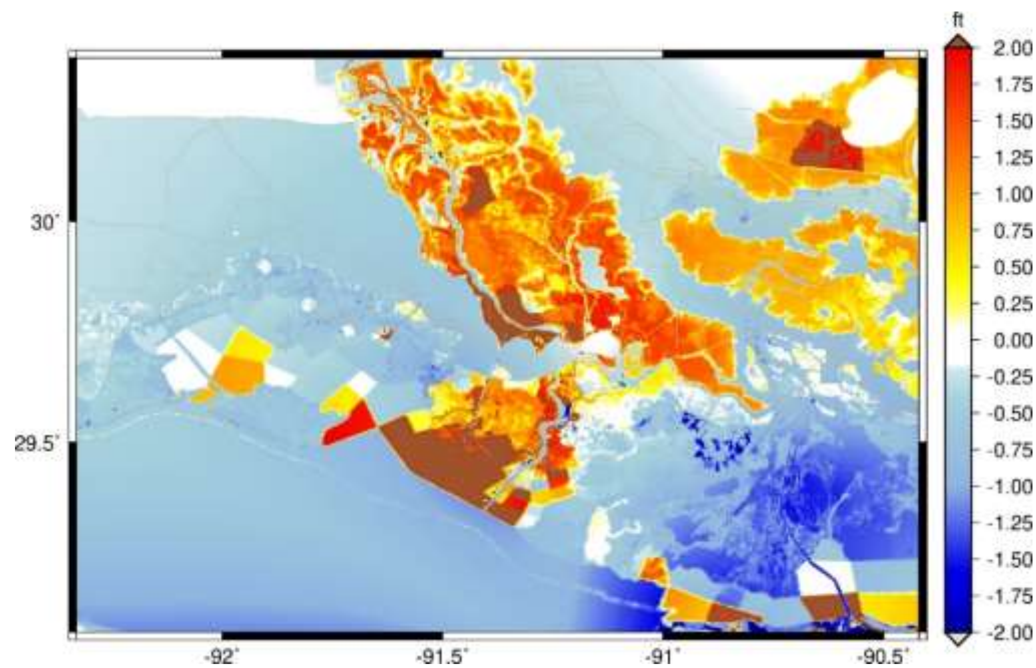

Figure 177. Change in topography and bathymetry in ADCIRC in the higher scenario for Year 50.

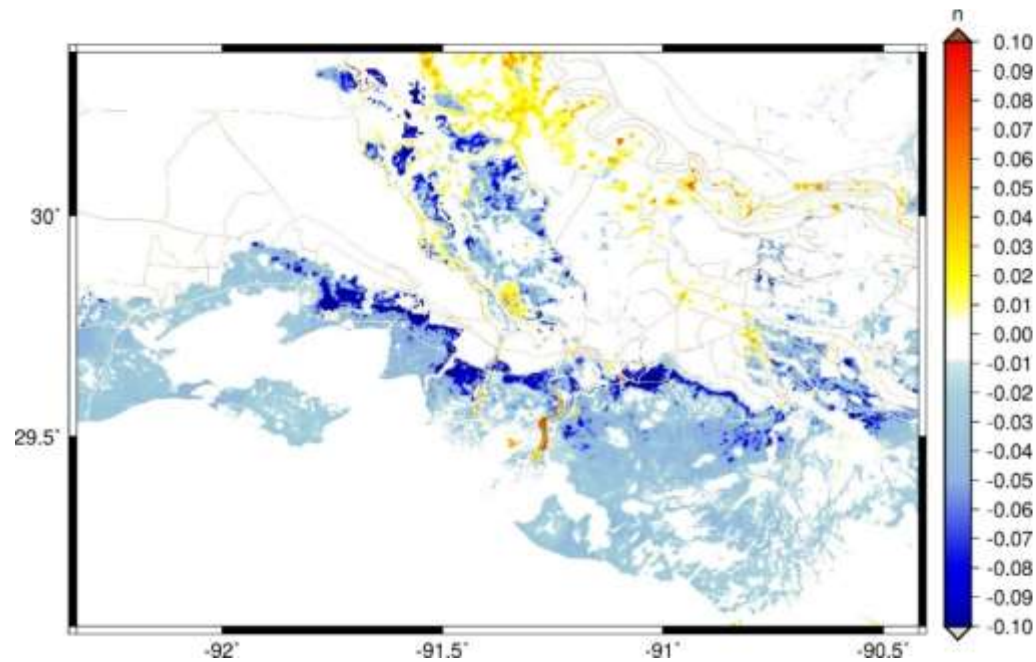

Figure 178. Change in Manning's n in ADCIRC in the higher scenario for Year 50.

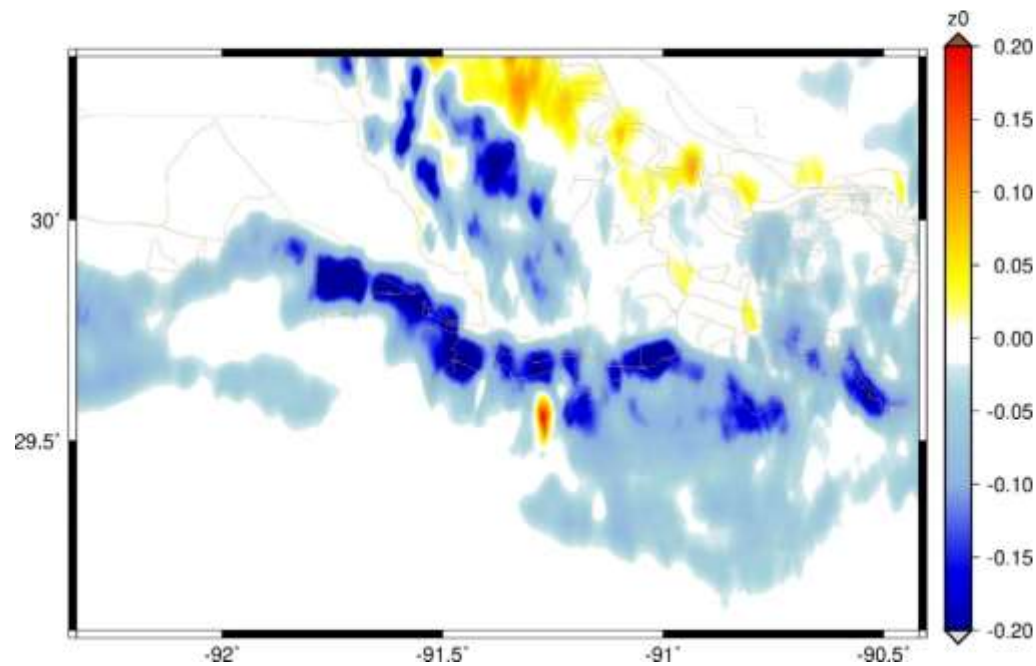

Figure 179. Change in directional wind reduction in ADCIRC in the higher scenario for Year 50.

Like the lower scenario, the higher scenario also shows surge increasing related to SLR and decreases in frictional resistance and deepening bathymetry allow surge to penetrate further inland. The Berwick polder inundates like the lower scenario's Year 30 and Year 50 results; however, by Year 50 in the higher scenario, the Berwick polder is almost fully inundated during this event.

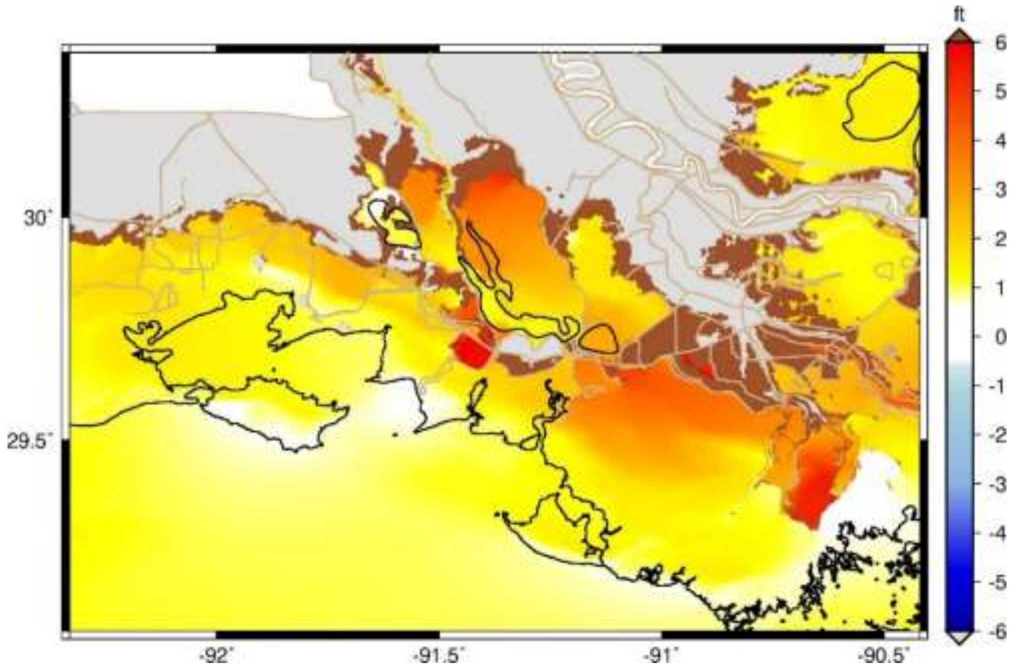

Figure 180. Change in peak water surface elevation between Year 30 and Year 0 in the higher scenario.

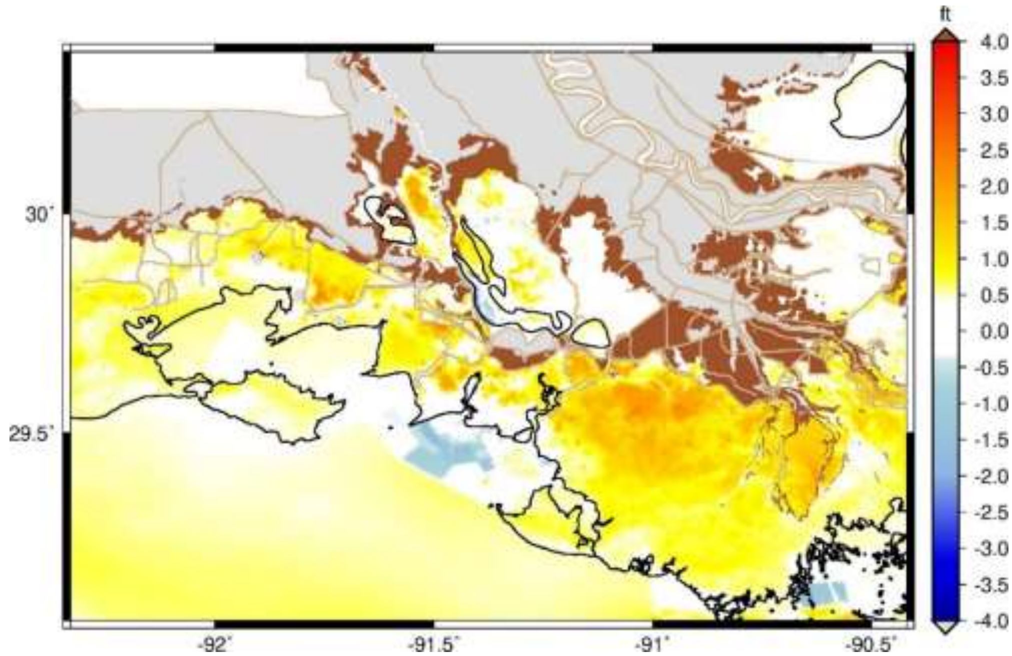

Figure 181. Change in peak wave height between Year 30 and Year 0 in the higher scenario.

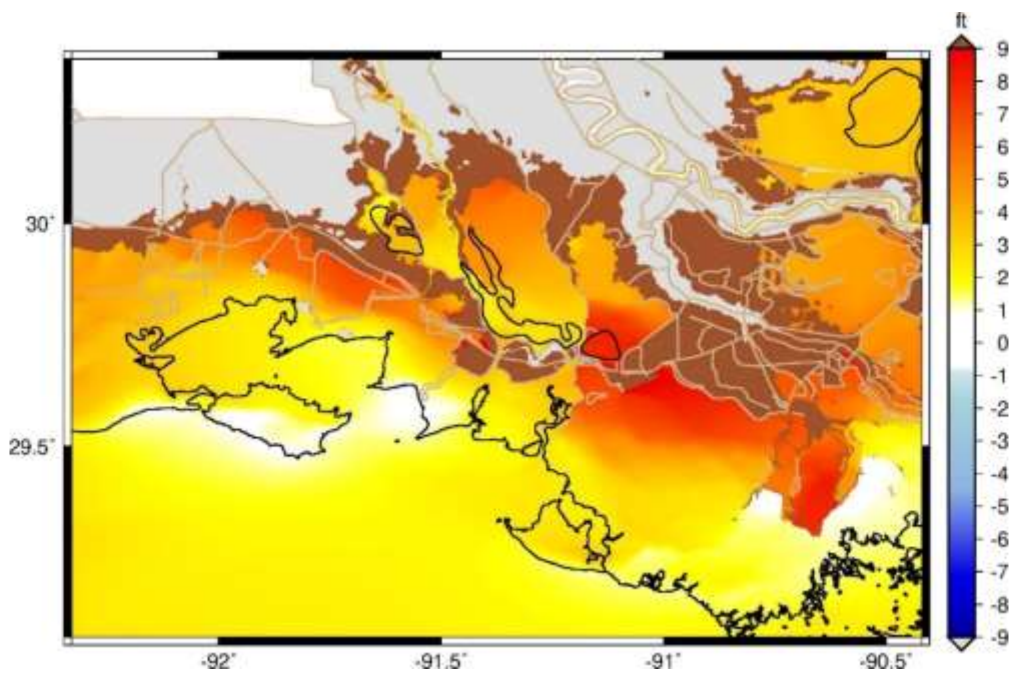

Figure 182. Change in peak water surface elevation between Year 50 and Year 0 in the higher scenario.

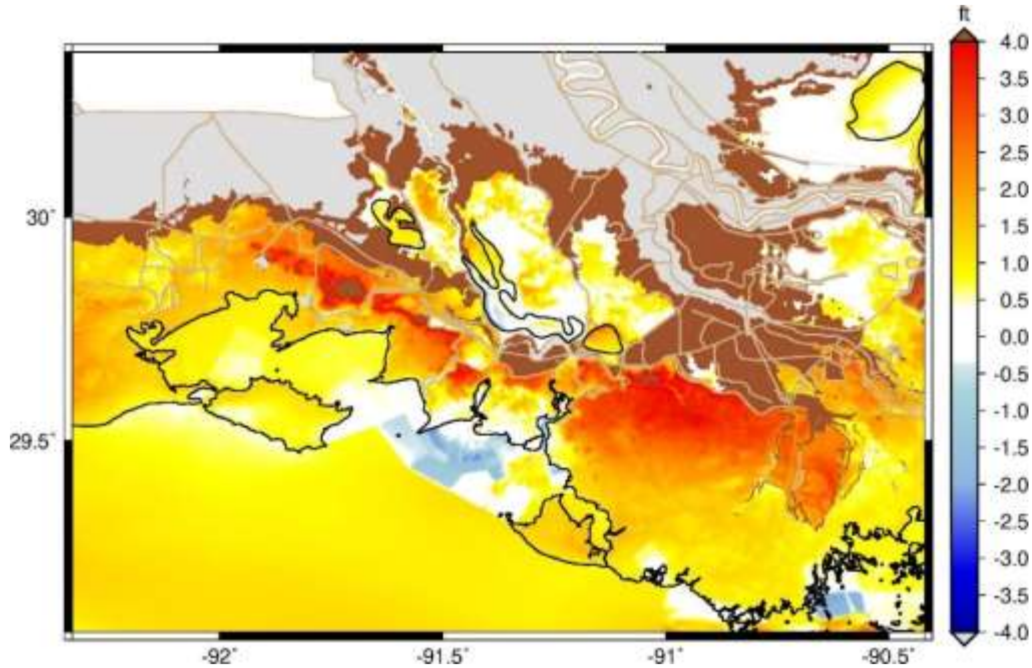

Figure 183. Change in peak wave height between Year 50 and Year 0 in the higher scenario.

5.4 FLOOD DEPTH PROJECTIONS

LOWER SCENARIO

Figure 184 shows the 10% annual chance (1 in 10-year) flood depths for Central Coast area in the lower scenario when projecting forward in a FWOA. In early decades, depths are less than 10 feet in most locations; while until Year 50, depths are less than 12 feet in most locations. The areas with greater inundation are mainly in an unpopulated bay area enclosed by Vermilion Bay, West Cote Blanche Bay, and Marsh Island. Populated areas including Abbeville and Morgan City have less than 4 feet of depth in all time periods.

Over time, 10% AEP flood depths increase moderately in both magnitude and extent (Figure 185). The sporadic part of the lower Abbeville Bay area experiences a 1-2 foot increase in flood depths in year 10. Then, in year 40, the extent of flooding expands to the entire area surrounding Vermilion Bay and Marsh Island while the magnitude maintains a 1-2 foot increase. By Year 50, nearly the entire bay area has an increase of over 3 feet in flood depths, except for Marsh Island. The area west of Morgan City, including Atchafalaya River and Yellow Bayou, keeps mostly unflooded over time while the half-enclosed area to the north of Morgan City, has flood depths since the early decades; the increase of flooding does not change dramatically though. The enclosed area to the south of Morgan City avoids 10% AEP flooding all through Year 50.

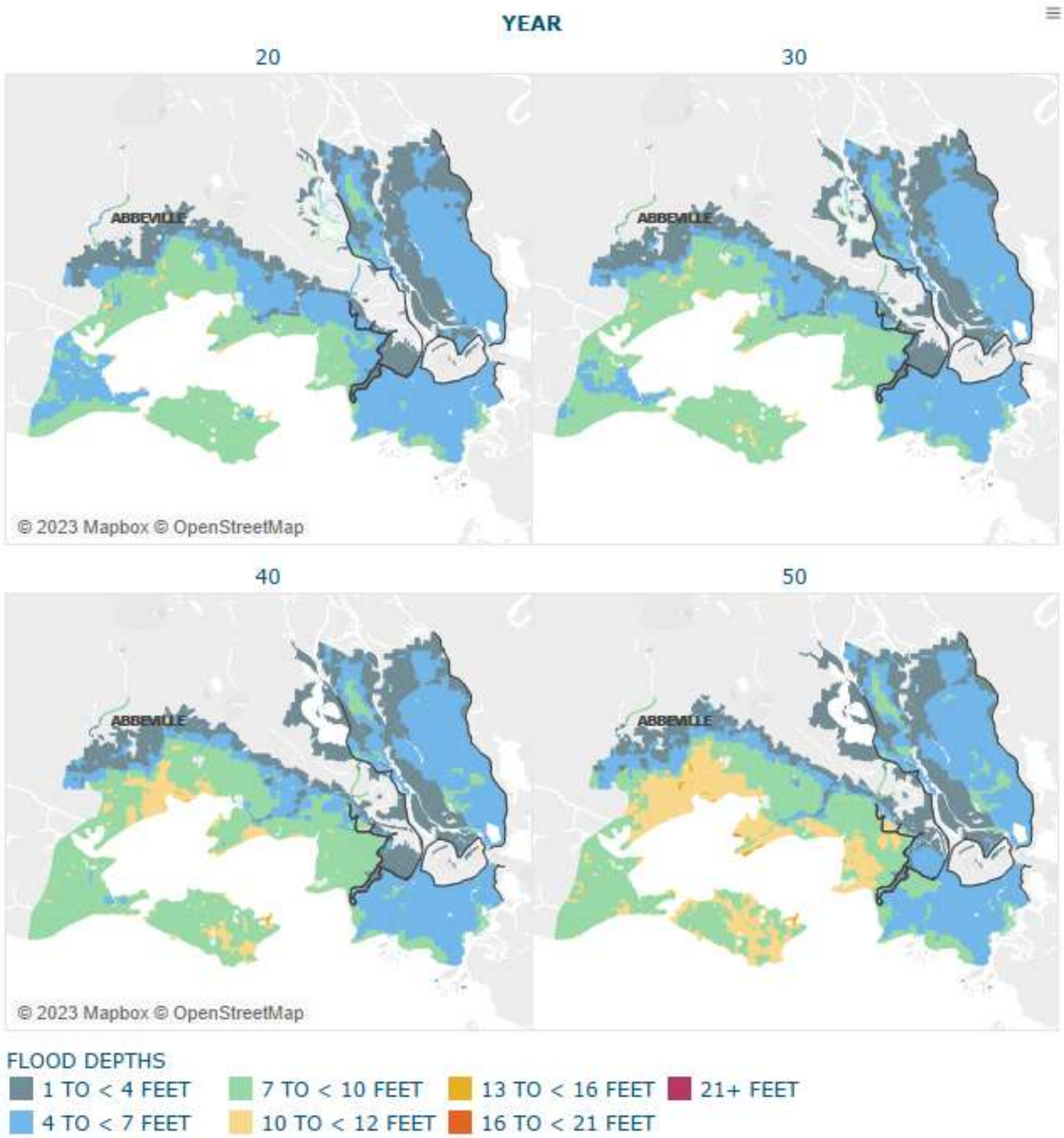

Figure 184. 10% annual chance (1 in 10-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

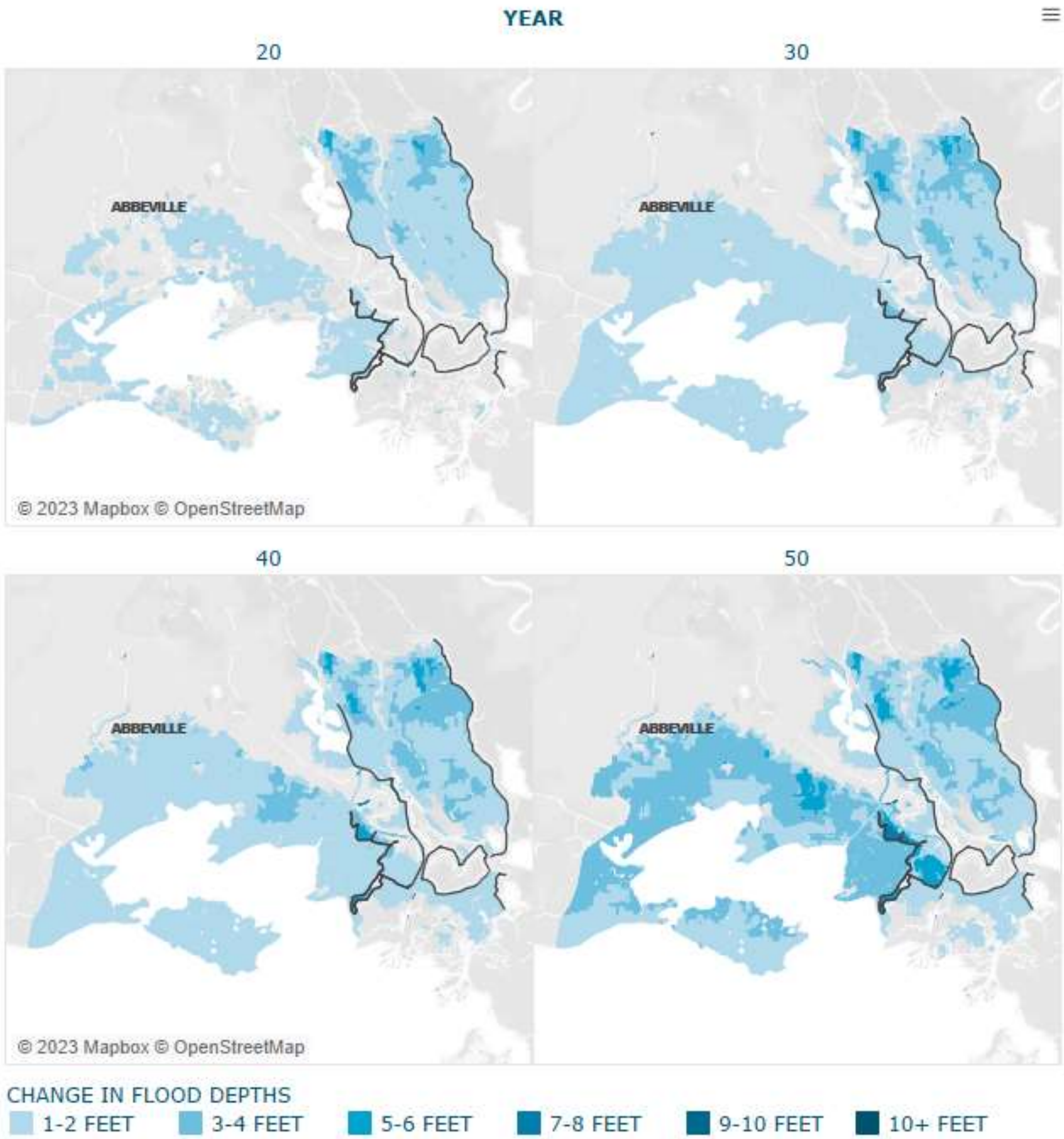

Figure 185. Change in 10% annual chance (1 in 10-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The 1% AEP (1 in-100-year) flood depths have substantially larger magnitude and extent in Central Coast area compared to the 10% AEP depths (Figure 186). For the bayou along the bay area, flood depths are over 10 feet around Avery Island and Glencoe, up to over 16 feet in selected areas, such as the north of Vermilion Bay and West Cote Blanche Bay, and the southern Marsh Island, in Year 20. Over time, the greater depths extend to the whole bay area. Noticeably, in the protected areas around

Morgan City, flood depths are under 10 feet even through Year 50 except for the wide top of the funnel-shape protection system, including areas such as Centerville and Garden City. The enclosed protected area around Berwick to the south of Morgan City sees inundation starting from year 10, driven largely by rainfall, which stays relatively constant at 1 to 4 feet over time.

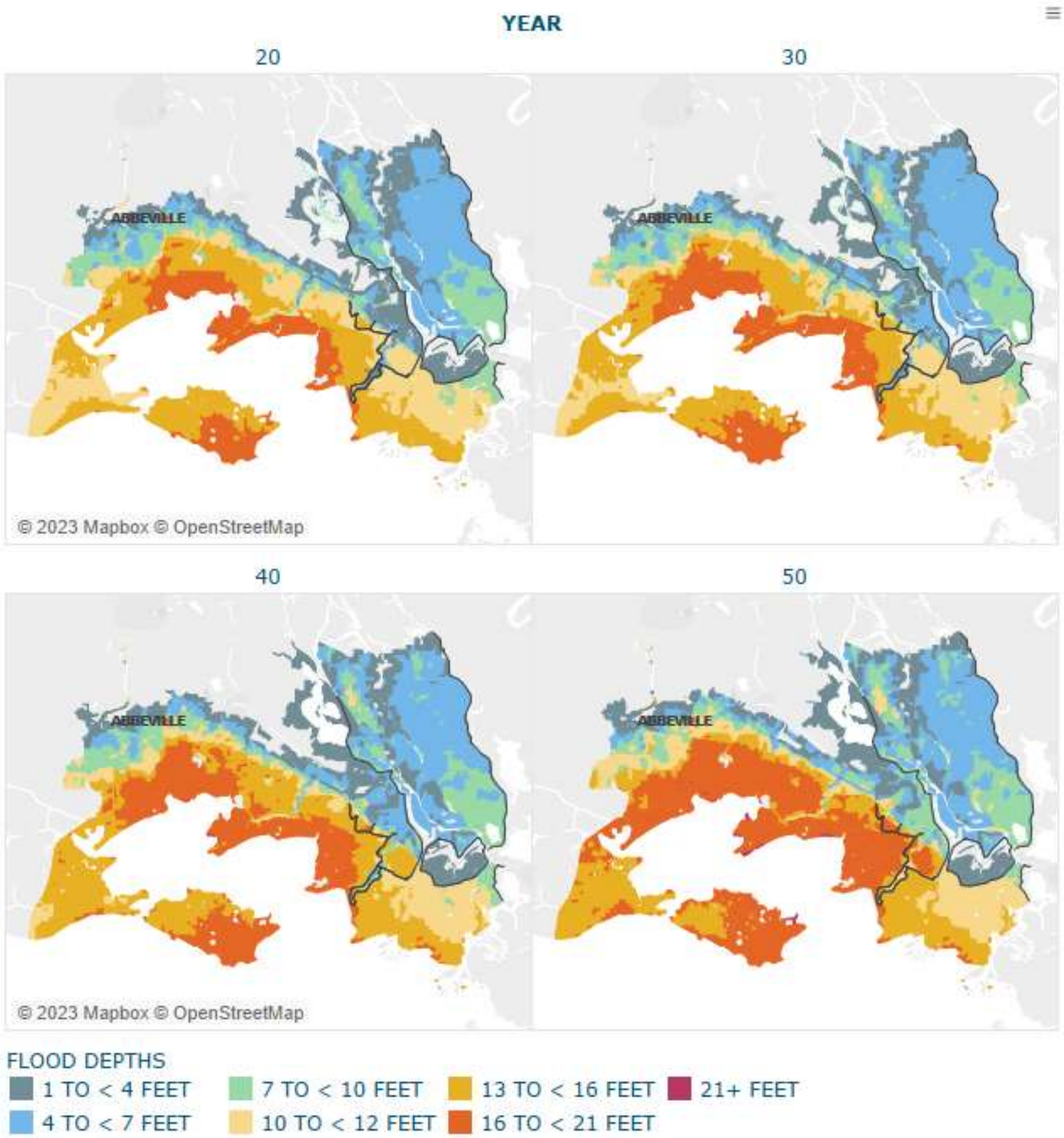

Figure 186. 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Figure 187 shows the changes in 1% (1 in 100-year) annual chance flood depths in a lower scenario. The largest increases over time happen in southwest Yellow Bayou along Bayou Teche and reaches 9 to 10 feet in Year 50. The inundation in protected areas to both south and north of Morgan City stays relatively unchanged.

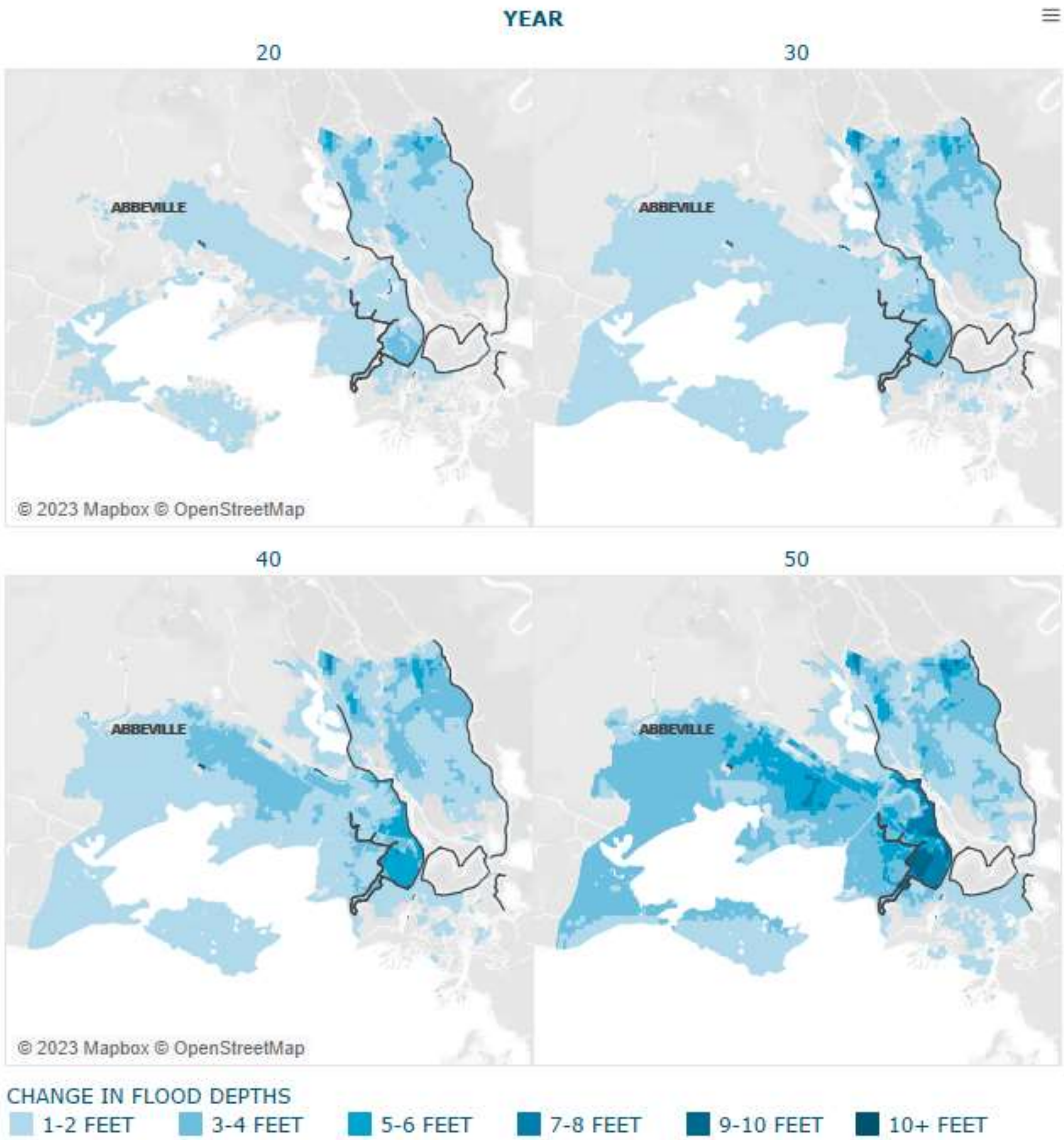

Figure 187. Change in 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

HIGHER SCENARIO

Flood depths in the Central Coast region with a 10% annual chance in a higher scenario are shown to have a larger extent than in the lower scenario (Figure 188). This pattern is not obvious in Year 20. But starting in Year 30, the areas with higher than 10 feet of flood depths originate from the north of Vermilion Bay, then expand to nearly the whole bay area in Year 50. The area southeast of Abbeville has flood depths greater than 13 feet, while in the lower scenario, the flood depths keep below 12 feet over time. However, in those protected areas around Morgan City, flood depths are consistently under 7 feet in most areas except northeast of Morgan City and east of Lake Fausse Pointe have over 10 feet of flooding, showing very similar patterns between these two scenarios at this return period.

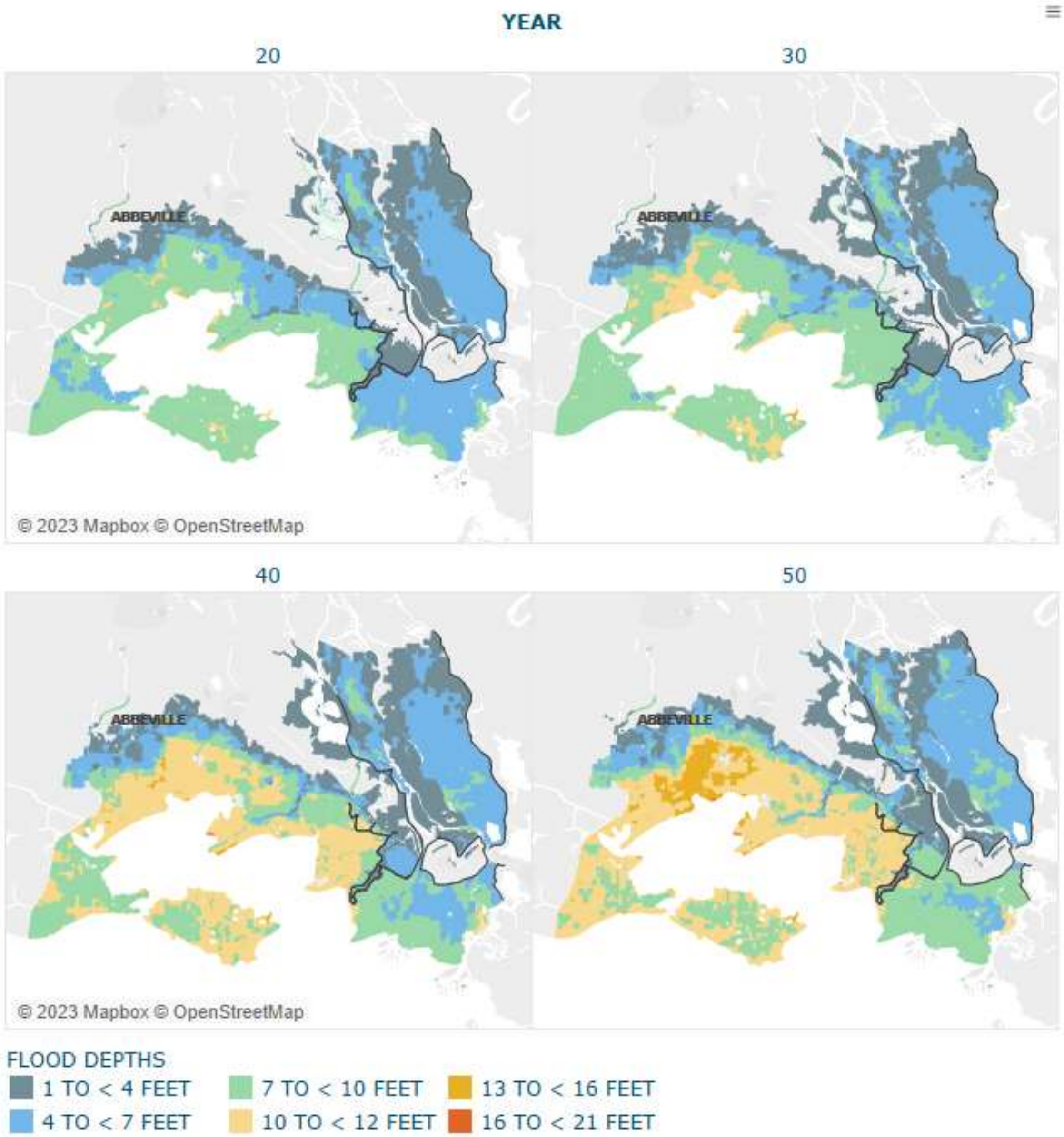

Figure 188. 10% annual chance (1 in 10-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

In most areas, the rate of change in 10% annual chance is modest (Figure 189). The largest increases of flood depths occur in southwest Yellow Bayou along Bayou Teche, consistent with the lower scenario. The ability of the levees encompassing this area to protect these communities decreases as time goes on. The communities on the southwest side of Bayou Teche also experience noticeable increase, with an approximate 1-2 foot rate of change per decade.

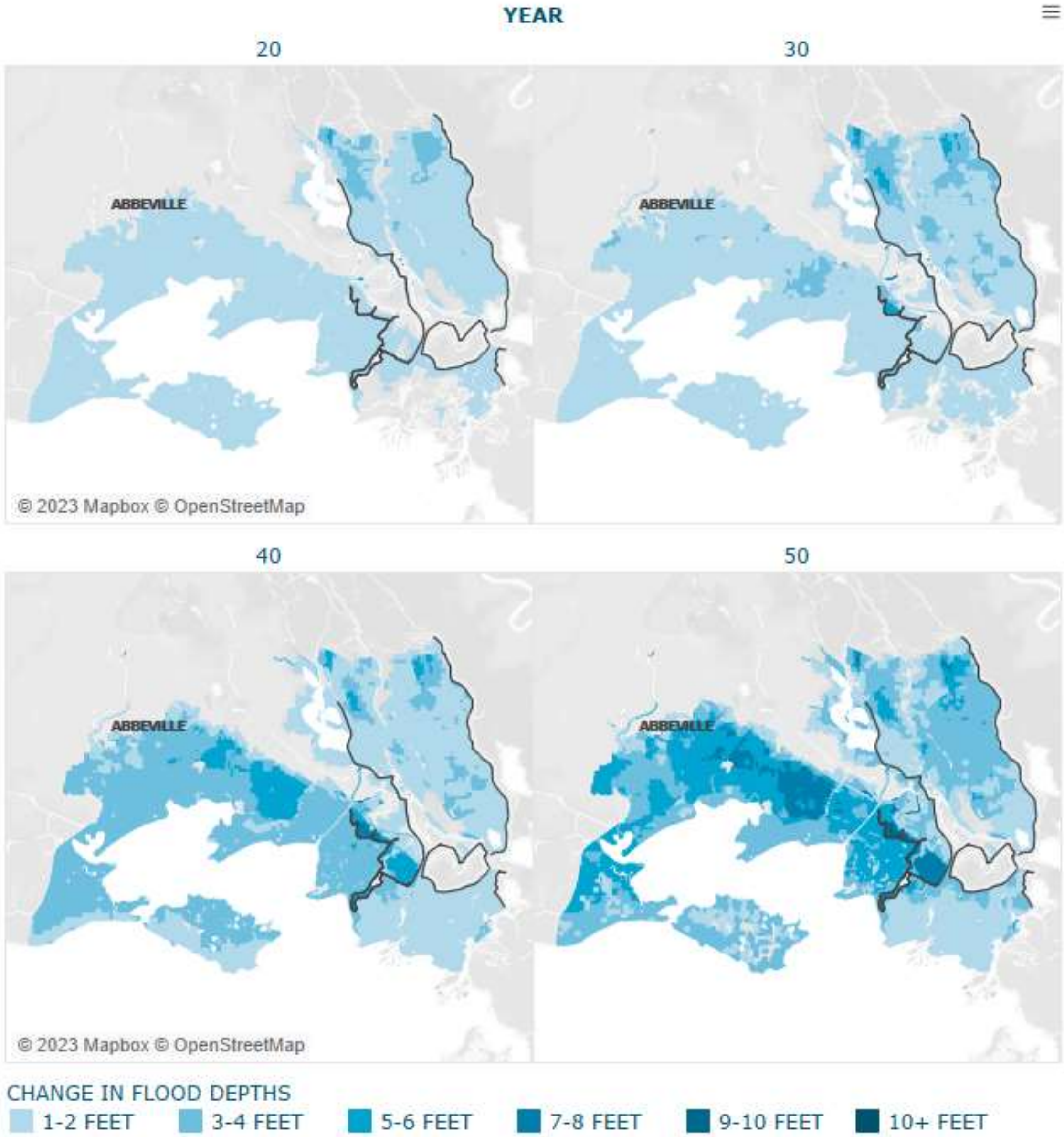

Figure 189. Change in 10% annual chance (1 in 10-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

For 1% annual chance flood depths in a higher scenario, the polarization in spatial pattern in Central Coast is further aggravated (Figure 190). The northside of Vermilion Bay and West Cote Blanche Bay and southern Marsh Island have flood depths over 16 feet starting in Year 20. Over time, areas with over 16 feet of inundation reach nearly the entire bay area; populated communities such as New Iberia and Lydia have over 21 feet of flood depths in Year 50. Most of the protected areas around

Morgan City have less than 12 feet of flood depths through Year 50. But, as in other scenarios, the protection of the wide top of the funnel-shape levees (to the southwest of Morgan City) fades over time. Many areas of this region have over 16 feet of flooding by Year 50.

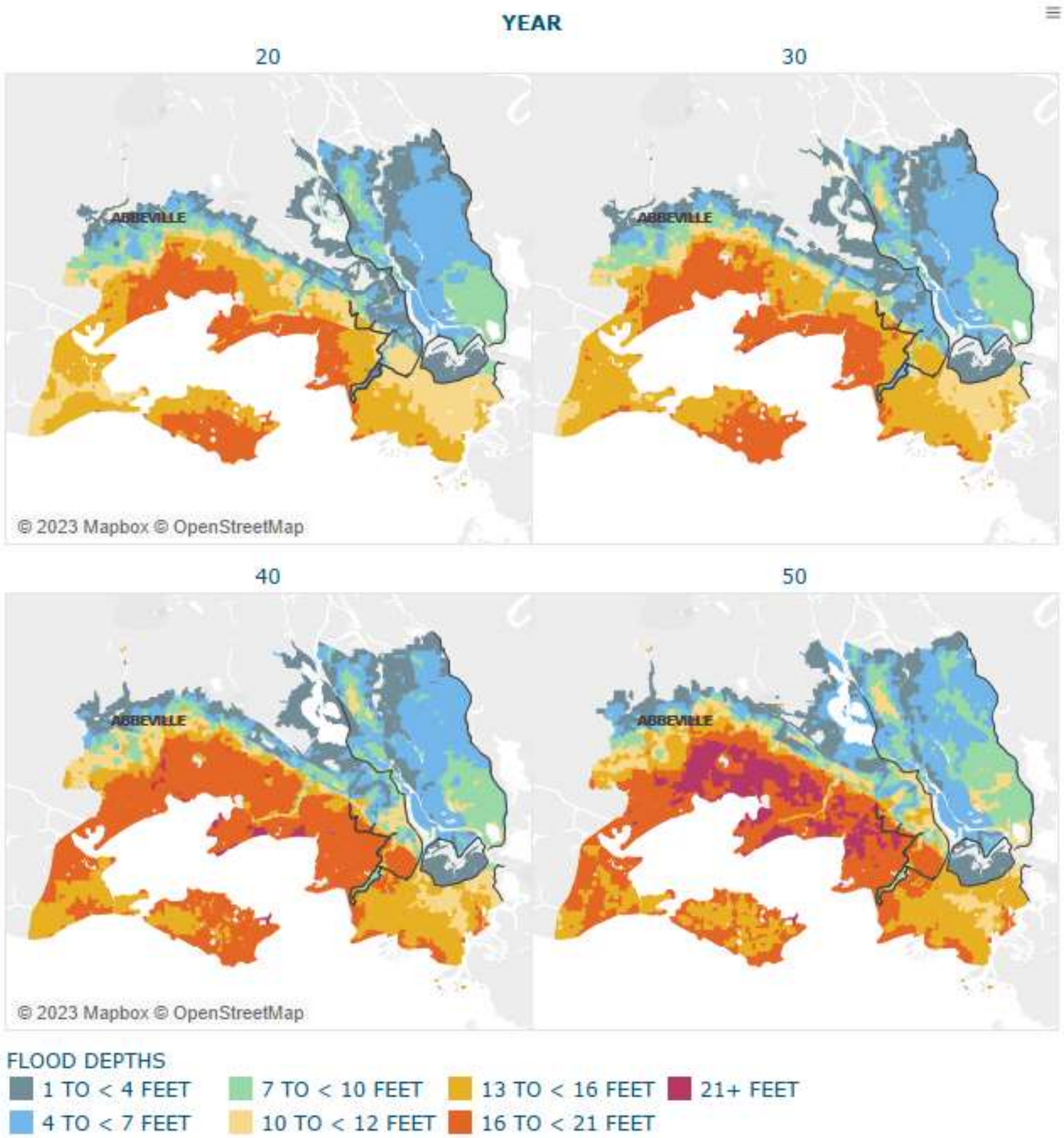

Figure 190. 1% annual chance (1 in 100-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The areas along Bayou Teche still have the largest change in flood depths over time, reaching 10 feet in some areas in Year 50 (Figure 191). In the protected areas, flood depths increase modestly, with a 0.5-1 foot rate of change per decade.

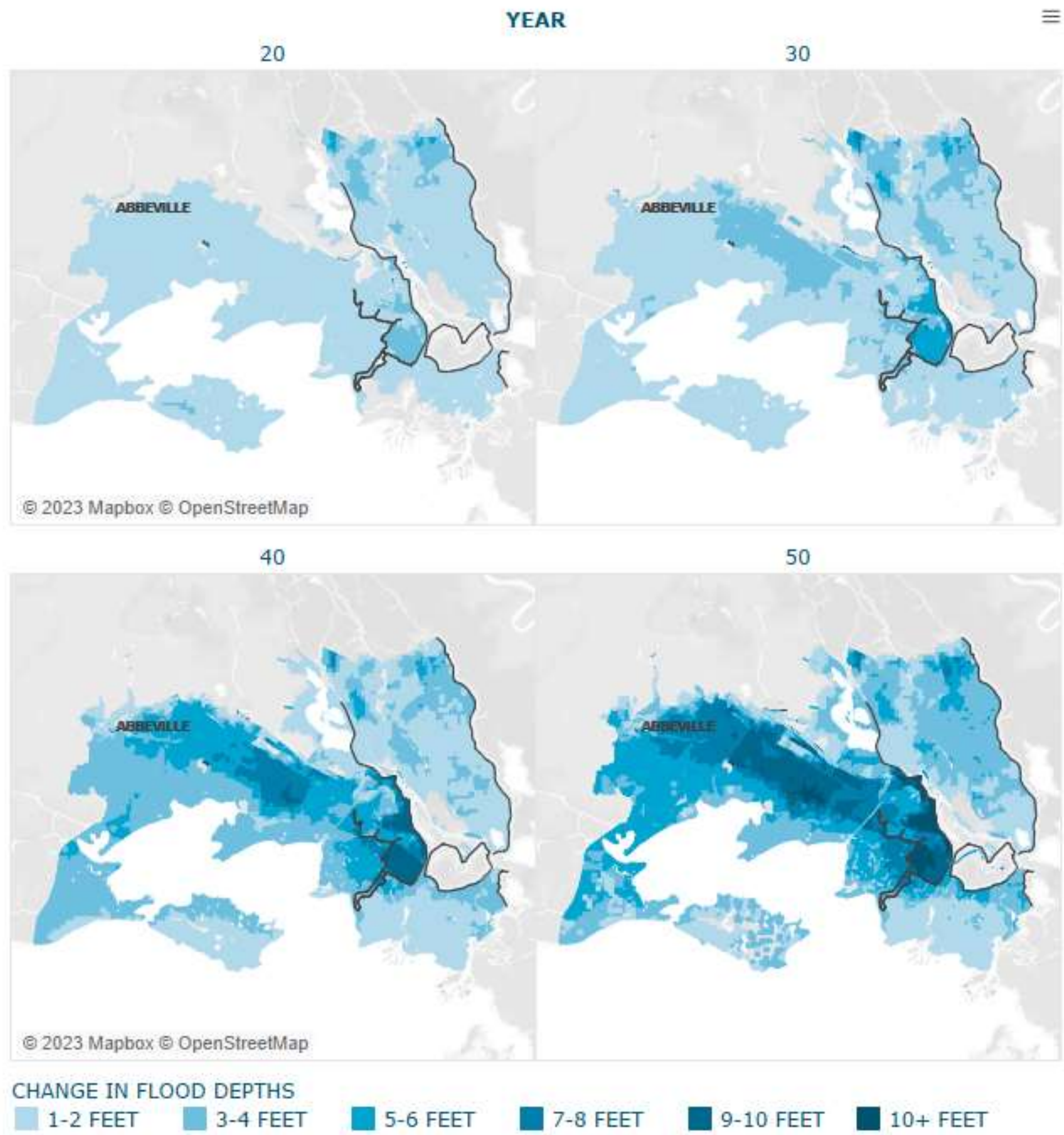

Figure 191. Change in 1% annual chance (1 in 100-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

DISCUSSION

Hazard estimates for the Central Coast region show increases in both the extent and depth of flooding over the period of analysis. These increases are generally linear in both lower and higher scenarios. The areas around Vermilion Bay, West Cote Blanche Bay, and Marsh Island always have larger flood depths than other areas in the Central Coast region. A large part of this area is unpopulated and unprotected, but it is notable that flood depths encroach northward to farmlands and populated communities along Bayou Teche, such as New Iberia and Erath. These communities have the greatest increase of flood depths over time across a range of return periods. This increase is likely explained by the lack of management of the large quantities of lakes and rivers in the marsh area.

The spatial pattern of flood depths is consistently polarized over time in both scenarios. Eastern Central Coast, including protected areas around Morgan City has lower depths than other parts of the region over time. An exception is at the northern end of the Sale Levee System where flooding and overtopping occur in communities such as Centerville, Calumet, and Garden City even though they are protected. In Year 50, 1% AEP flooding even extends to Patterson to the west of Morgan City. The Atchafalaya Basin Spillway Levee may have an inability to protect these communities over time.

Other protected areas, both to the north and south of Morgan City and protected by the Bayou Benoit Levee and other levee roads, do not see a large amount of flooding even for 1% AEP flood depths in the higher scenario. This is likely due to the 2023 Coastal Master Plan's assumptions about the maintenance and improvements of levee systems.

5.5 FLOOD DAMAGE PROJECTIONS

LOWER SCENARIO

Figure 192 shows the percentage of single-family residences in communities with moderate exposure to flooding in a lower scenario from Year 20 to Year 50. The communities alongside the Vermilion Bay and West Cote Blanche Bay are more vulnerable than others, with over 80% structural assets in many areas exposing to 2% annual flood depths even at the early decades. Some of these areas (e.g., Marsh Island, western Vermilion Bay) make up a small percentage of the population of the Central Coast region, but some communities at the intersection of Charenton Drainage and Navigation Canal and Bayou Teche, such as Baldwin and Franklin, are populated. The overall change of extent and magnitude in the Central Coast region until year 40 is relatively modest but accelerates in Year 50.

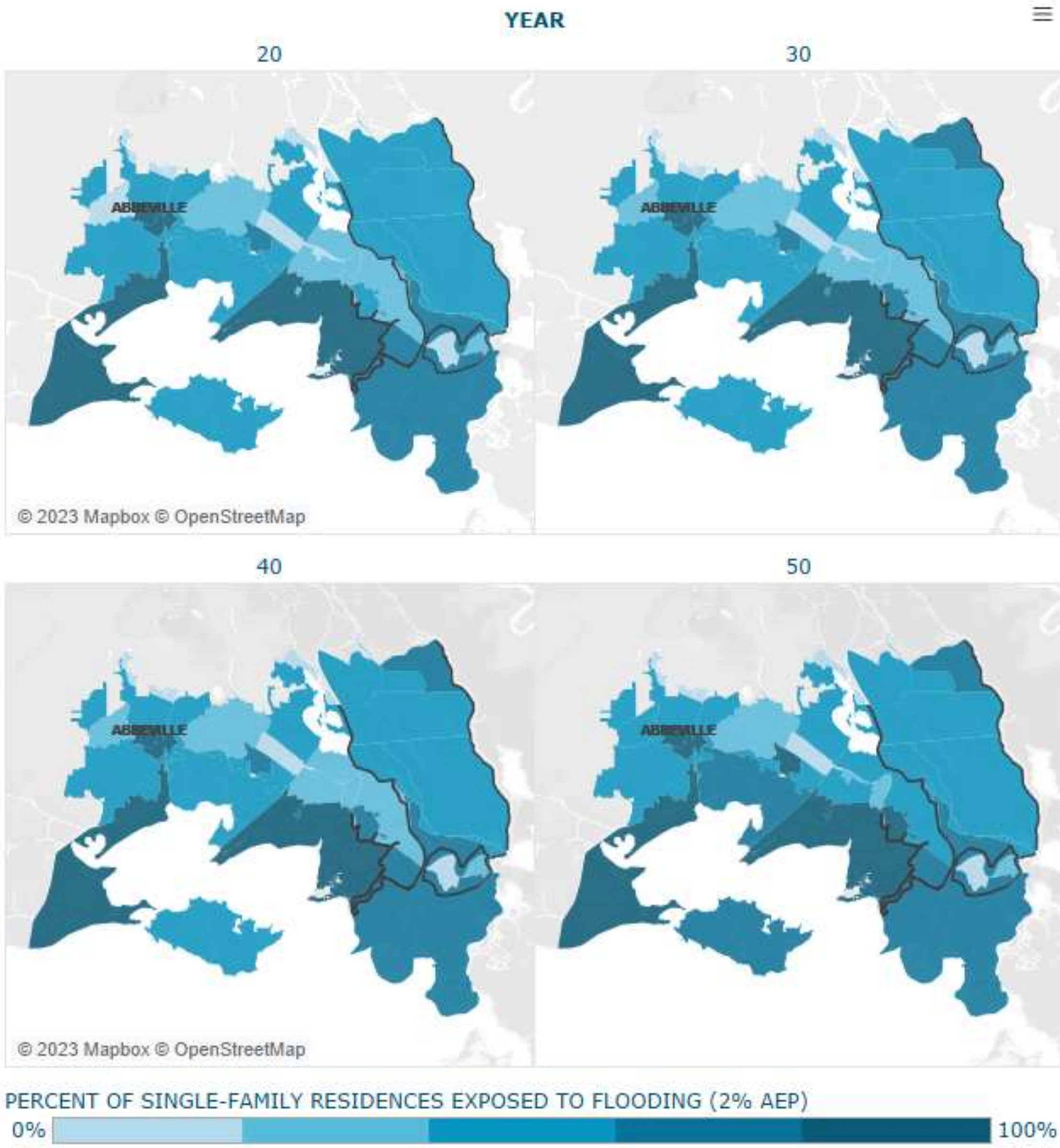

Figure 192. Residential structures exposed to 2% annual chance (1 in 50-year) flood depths above first floor elevation in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Figure 193 demonstrates the change of structure exposure results across the entire Central Coast region from Year 0 to Year 50. This is not a highly populated region, but the percentage of flooded structures is notable. The percentage of single-family residences not being exposed to 2% AEP flood event declines 44% to 34%, while severe exposure increases from 16% to 33% over these 50 years.

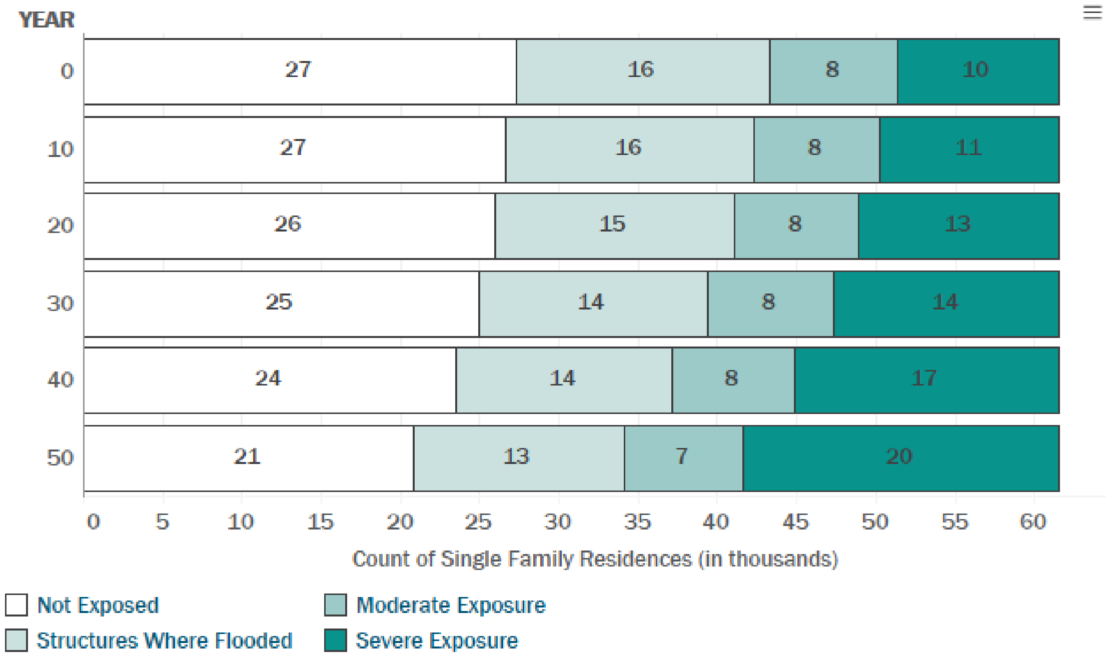

Figure 193. Residential structures exposed to 2% annual chance (1 in 50-year) flooding by exposure category in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile. Note: existing residences only, not accounting for population change.

The economic damage, including expected annual damage in dollars and expected annual structural damage, across the entire Central Coast region is summarized in Figure 194. The left pane shows EADD increases from $0.7 billion to $1.5 billion, more than doubling by Year 50. But the rapid increase only occurs in the last decade. Structure damage represents small percentage of the total EADD, even decreasing from 29% to 20% over time. Residential EASD increases from 622 to 1,191 over the period of analysis, with the largest increase in the last decade, and has a similar accelerating pattern as in EADD.

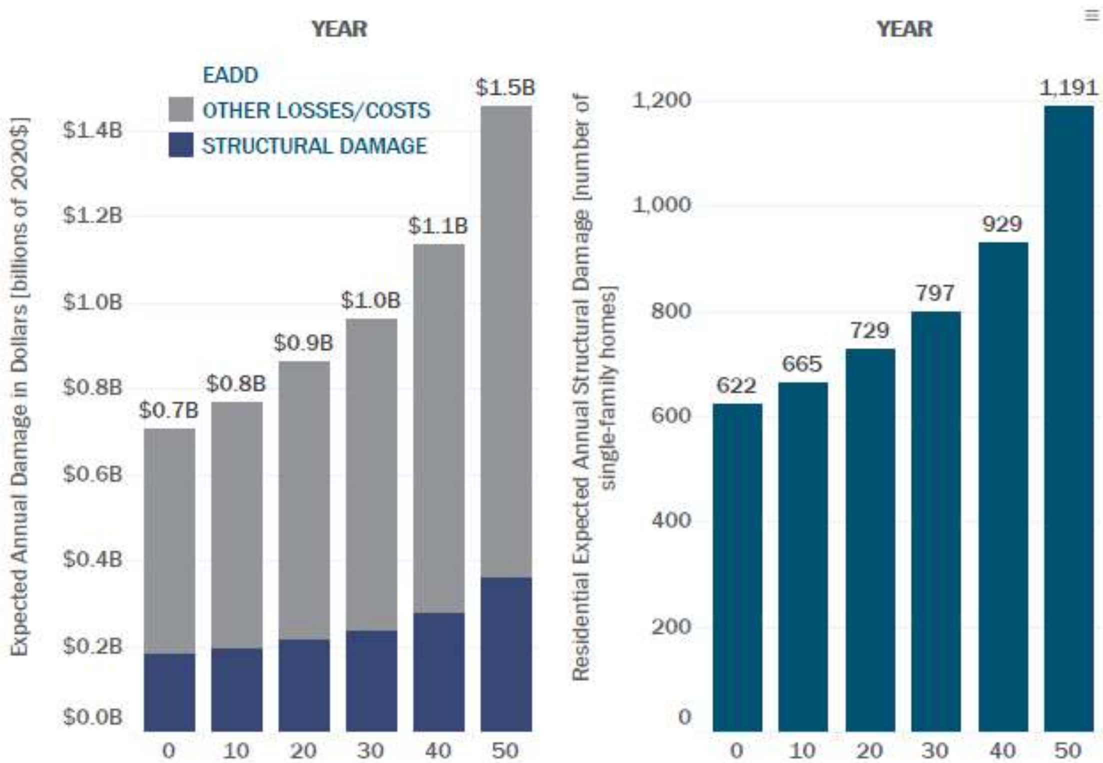

Figure 194. EADD (left) and residential EASD (right) in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

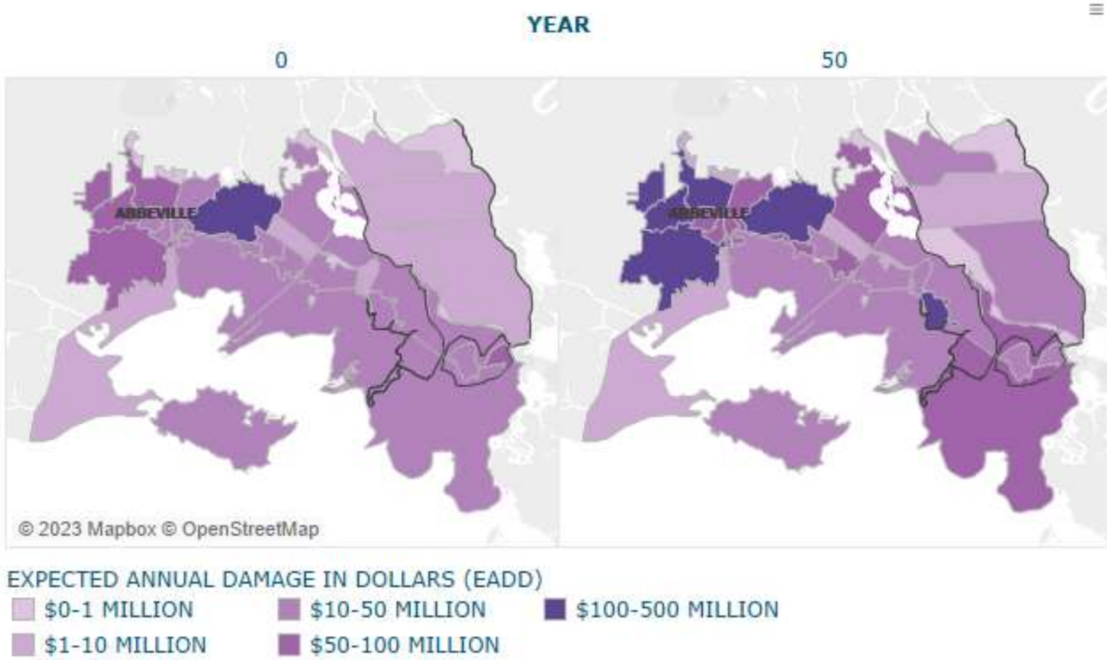

Figure 195. EADD by community in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

EADD by community in a lower scenario is shown in Figure 195. New Iberia has the largest concentrations of EADD in Year 0. By Year 50, communities with high EADD values expand to Vermilion and Franklin, with $100 million to $1 billion EADD. St Martin does not see much EADD in year 10 ($1-10 million) but has $10-100 million EADD in Year 50. EADD in eastern St. Mary Parish (e.g., Berwick/Siracusaville) decreases from $1-10 million to less than $1 million from Year 0 to Year 50, due to relatively constant flood depth exceedances combined with declining populations.

Figure 196 summarizes the change in EADD by communities from Year 0 to Year 50. The largest change in EADD over time occurs in New Iberia and Franklin, with an increase of $100 million to $1 billion. Other populated communities along Bayou Teche also see an increase in EADD over time. The unprotected areas around Vermilion Bay and West Cote Blanche Bay, primarily rural areas outside of identified communities in southern St. Mary, Iberia, and Vermilion parishes, see no change or even decline in EADD over time.

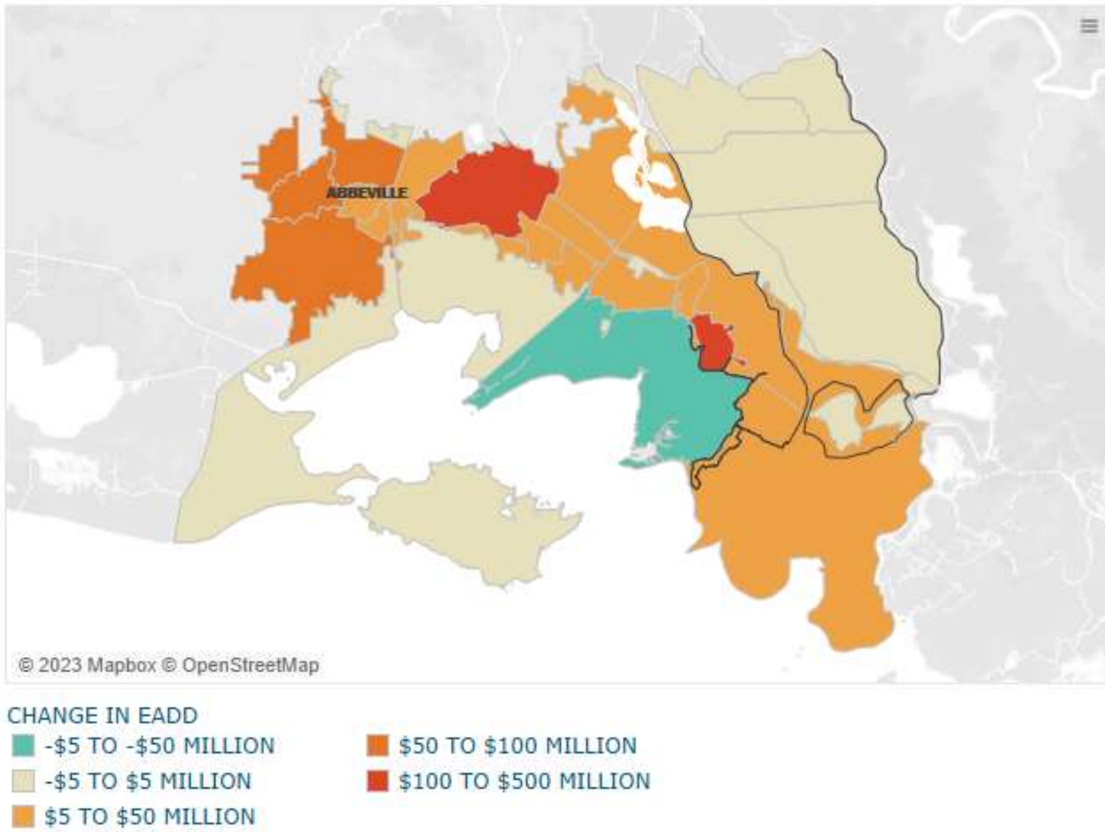

Figure 196. Change in expected annual damage by community in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile, Year 50 – Year 0.

Figure 197 depicts the change in EADD over time in selected communities. It highlights that EADD increases significantly in New Iberia in the lower scenario, more than doubling over the period of analysis. Other highlighted communities, including Franklin and Abbeville, show a modest trend of increase over time, while EADD in Morgan City/Berwick/Siracusaville is almost unchanged. This trend might be correlated to the decline or relatively unchanged population.

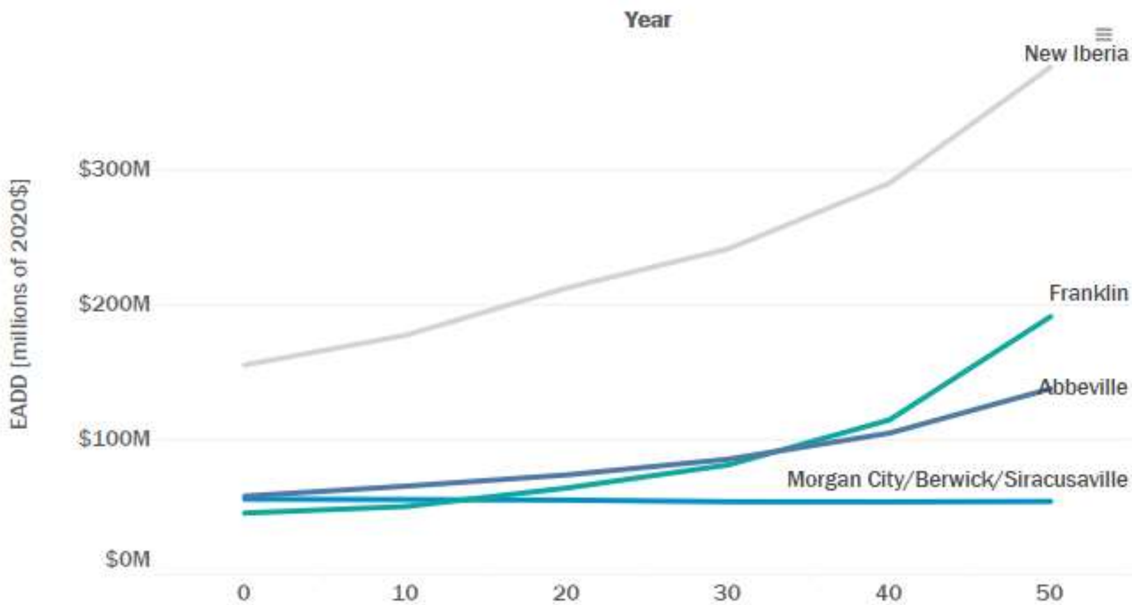

Figure 197. EADD in selected Central Coast communities over the 50-year simulation period in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

HIGHER SCENARIO

In future years in a higher scenario, the spatial pattern is similar to that in the lower scenario in the Central Coast region, except that the percentage of structural assets with more than moderate exposure is greater (Figure 198). The noticeable difference between these two scenarios is the set of communities extends further into the protect areas, such as St. Mary, by Year 50 in the higher scenario.

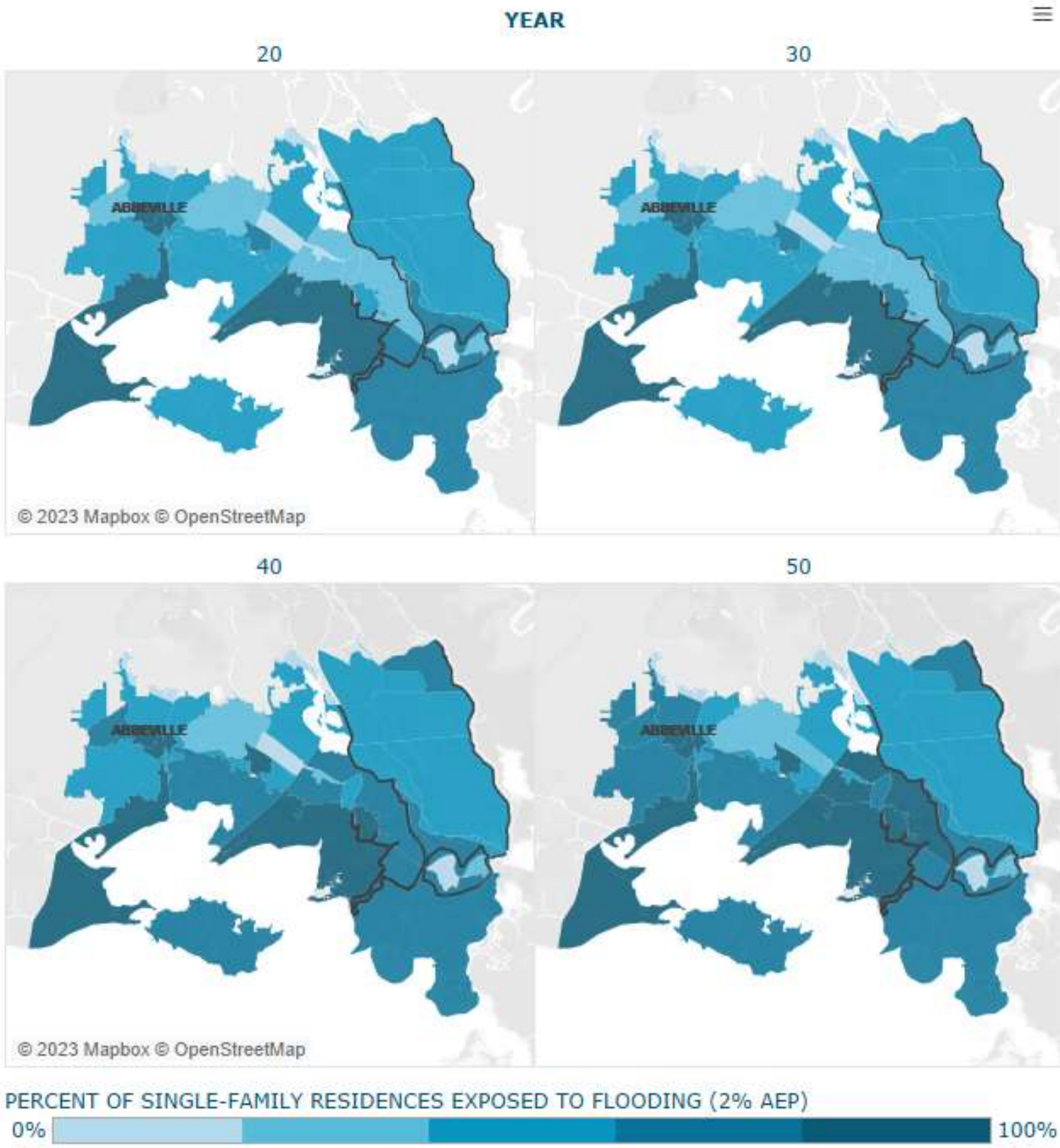

Figure 198. Residential structures exposed to 2% annual chance (1 in 50-year) flood depths above first floor elevation in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Turning next to the counts of single-family residences exposure, the percentage of structural assets with no exposure to 2% AEP of flooding decreases by 8% compared with that in the lower scenario in Year 50. The percentage of structural assets facing severe exposure to flooding increases by 10%, with the counts increasing from approximately 20,000 to 26,000 (Figure 199). 74% of residences are exposed to some level of flooding at the 2% AEP in this scenario by Year 50.

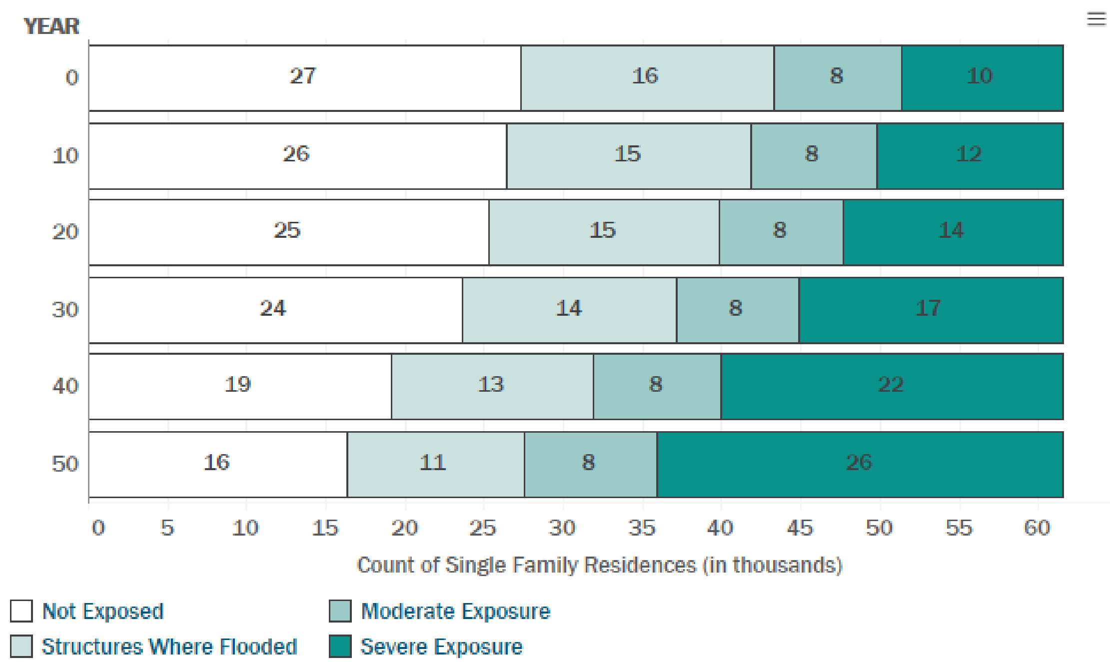

Figure 199. Residential structures exposed to 2% annual chance (1 in 50-year) flooding by exposure category in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

EADD and EASD in a higher scenario are shown in different panes in Figure 200. This figure highlights that both EADD and EASD triple from Year 0 to Year 50, while in the lower scenario, they are just doubling. The accelerating pattern is similar to the lower scenario, in which the rapid increases happen in last two decades. Damage to physical structures represents less than one-third of EADD through 50 years; this ratio is close to that observed in the lower scenario.

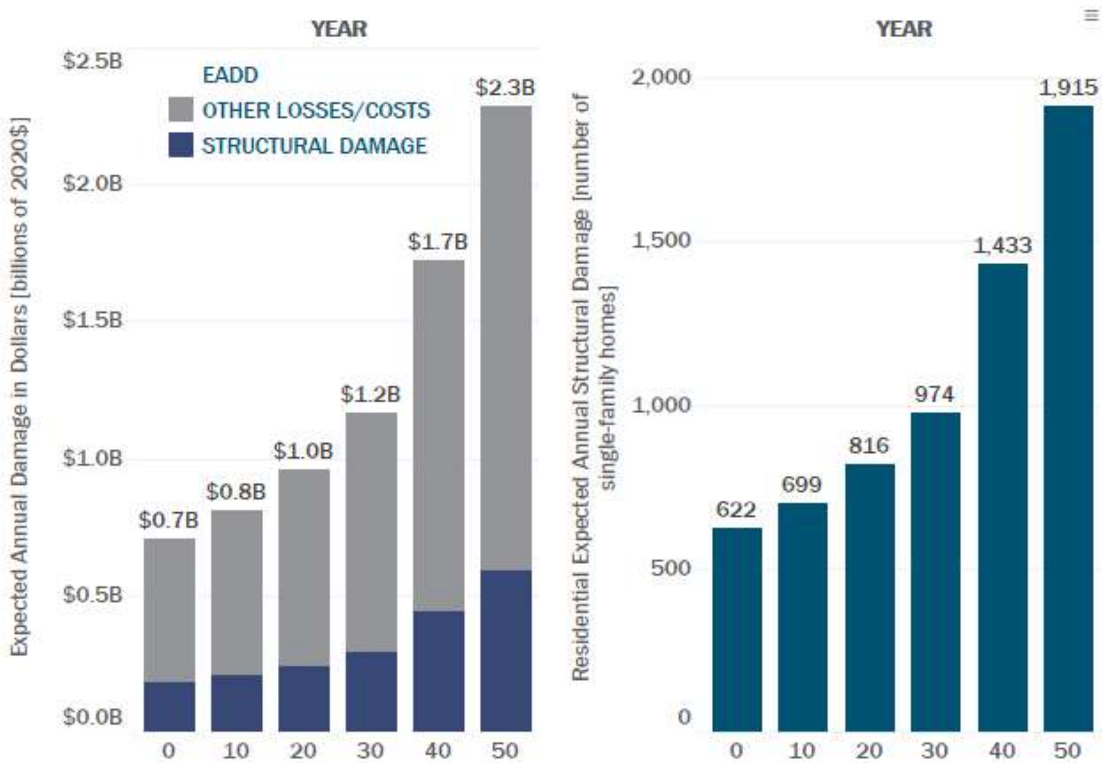

Figure 200. EADD (left) and residential EASD (right) in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The spatial pattern and the magnitude shown in the higher scenario (Figure 201) are similar to the lower scenario, with minor exceptions. New Iberia and Franklin still have the largest EADD concentration as in the lower scenario, while the northern portion of the Central Coast region, such as Iberia, has a higher EADD.

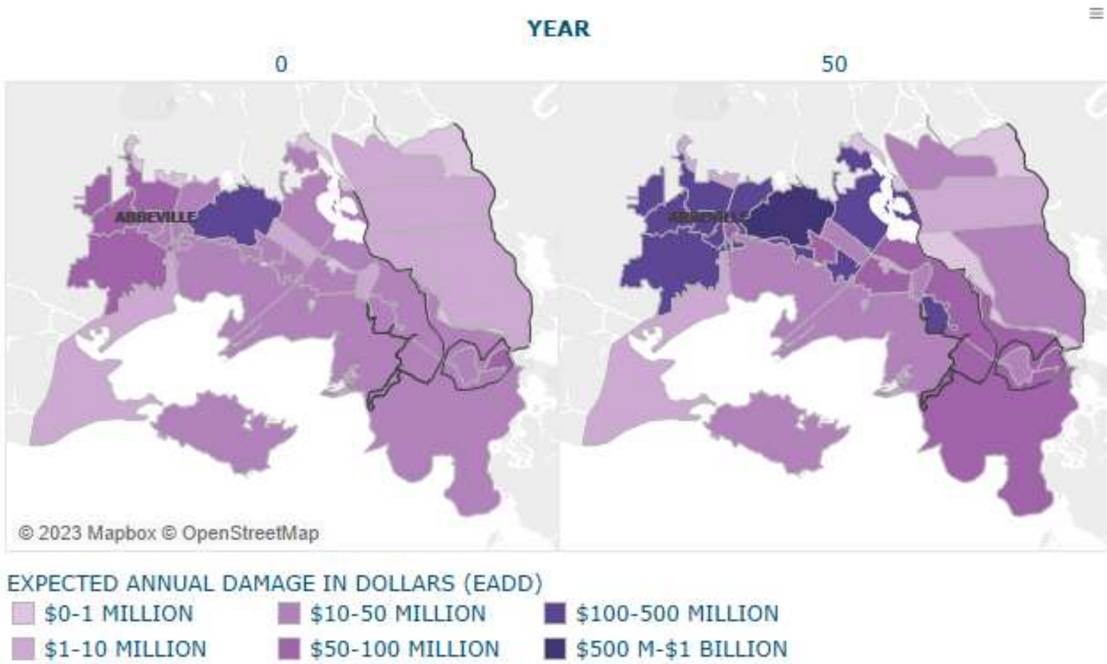

Figure 201. EADD by community in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The spatial distribution of the change in EADD by community in a higher scenario somewhat different from that in the lower scenario (Figure 202). Communities that under the lower scenario saw a negative increase in EADD, such as protected areas in Patterson, face an increase of over $1 million in EADD over time. The south portion of Iberia has no change in the lower scenario but has a $1-10 million increase in EADD in this scenario.

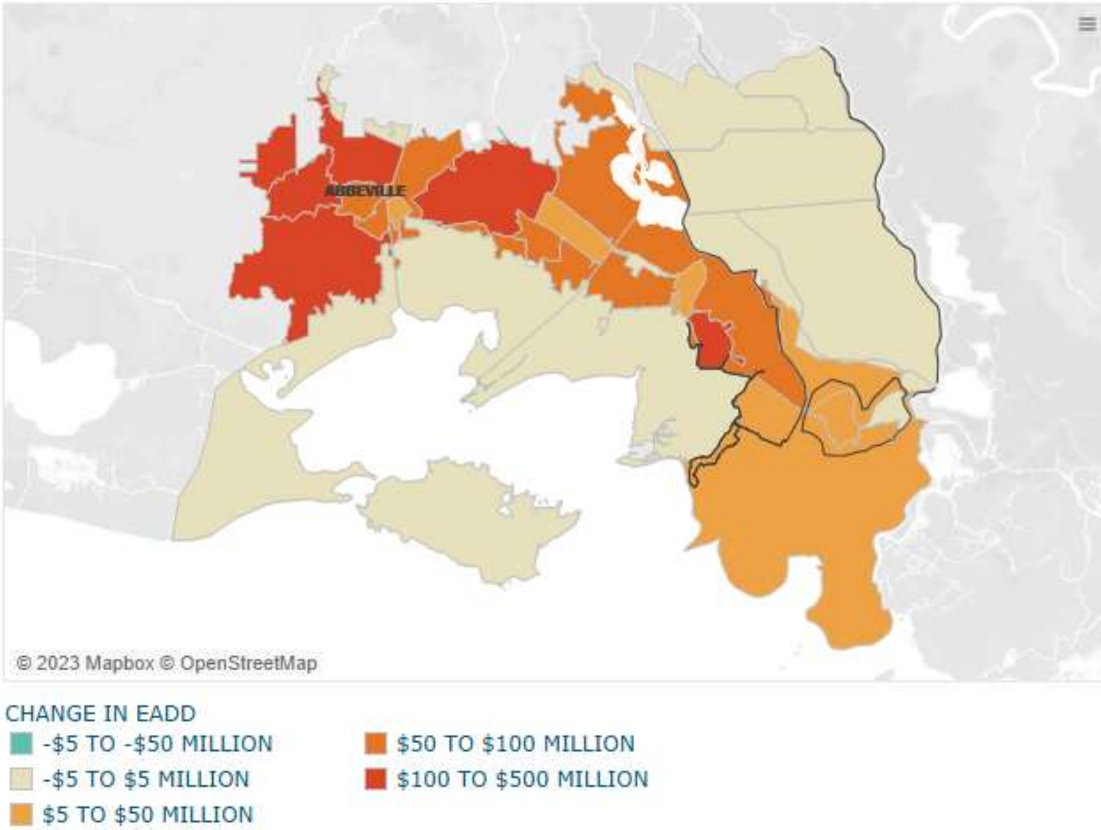

Figure 202. Change in expected annual damage by community in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile, Year 50 – Year 0.

In the higher scenario, EADD increases faster in most of the selected communities (Figure 203). New Iberia still has the largest increase and the largest value of EADD over time. By comparison, Franklin and Abbeville show a more modest increase and value. These communities have a tipping point in Year 30, followed by a higher increasing rate. Morgan City/Berwick/Siracusaville shows unchanged EADD over time, as in the lower scenario.

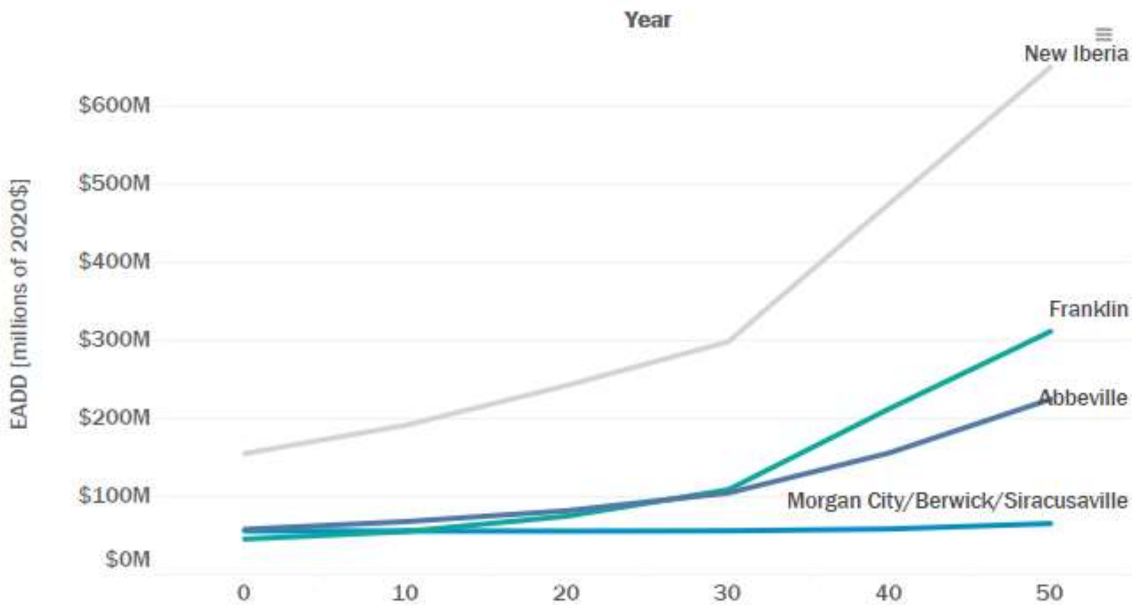

Figure 203. EADD in selected Central Coast communities in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

DISCUSSION

Projected economic damage in the Central Coast region increases linearly in the early decades, but with a higher accelerating rate in the last decade in the lower scenario and in the last two decades in the higher scenario. This is likely due to the different assumptions of SLR rate in the two scenarios. The spatial pattern of structural assets exposure follows the flood depths results in both scenarios: the unprotected communities with substantial exposure (e.g., Vermilion, southern St. Mary, southern Iberia) are largely on the north shore of Vermilion Bay and West Cote Blanche Bay, while the protected community of Franklin also faces severe exposure. It is notable that in both scenarios, over half of communities are facing exposure to flooding through a range of return periods; 74% of communities are flooded in Year 50 in the higher scenario. This is tied to rising sea levels and land subsidence in this coastal marsh area.

New Iberia has over $100 million in EADD in Year 0 in both scenarios. EADD in New Iberia and Abbeville shows an increase of over $100 million over the 50-year simulation period. The protected community of Franklin also has a substantial rise in EADD, while on the other side the levees, St. Mary shows declining EADD in both environmental scenarios. This appears to be due to the decrease in population over time.

6.0 CHENIER PLAIN

6.1 DESCRIPTION

GEOGRAPHY

The Chenier Plain is bounded by Vermilion Bay on the east and Sabine Lake at the Texas-Louisiana border on the west. The region encompasses two primary coastal basins, the Calcasieu-Sabine and Mermentau, which are divided by State Highway 27. The landscape of the Calcasieu-Sabine Basin on the west is dominated by two large water bodies, Calcasieu Lake and Sabine Lake and a system of coastal wetlands ranging from fresh to saline. Three wildlife preserves are in the Chenier Plain region, including two national wildlife refuges, Sabine and Lacassine, and one state wildlife management area, Rockefeller. The hydrology of this basin has been extensively altered by the construction of navigation channels including the GIWW and the Calcasieu Ship Channel as well as a network of smaller access canals. The Mermentau Basin to the east consists of two primary sub-basins, the Lakes Sub-basin north of State Highway 82 and the Chenier Sub-basin to the south. The Chenier Sub-basin primarily consists of a series of oak ridges known as cheniers separated by low salinity marshes.

Due to their high elevation relative to the surrounding landscape, the cheniers have historically served as the site of human settlement in the southern portion of the region (Figure 204). The northern portion of the Chenier Plain region, beyond the marshes and estuarine lakes, transitions to a coastal prairie landscape which encompasses non-saline tallgrass prairie vegetation atop the high elevation Pleistocene prairie terraces. Much of the development in the north is in the coastal prairie and incudes a combination of urban, suburban, and rural/agricultural development. This includes the Lake Charles Metropolitan Area in the north of the Calcasieu-Sabine Basin, with a combined population of just over 210,000 persons, and many smaller communities to the east, including Jennings, Lake Arthur, Gueydan, and Kaplan.

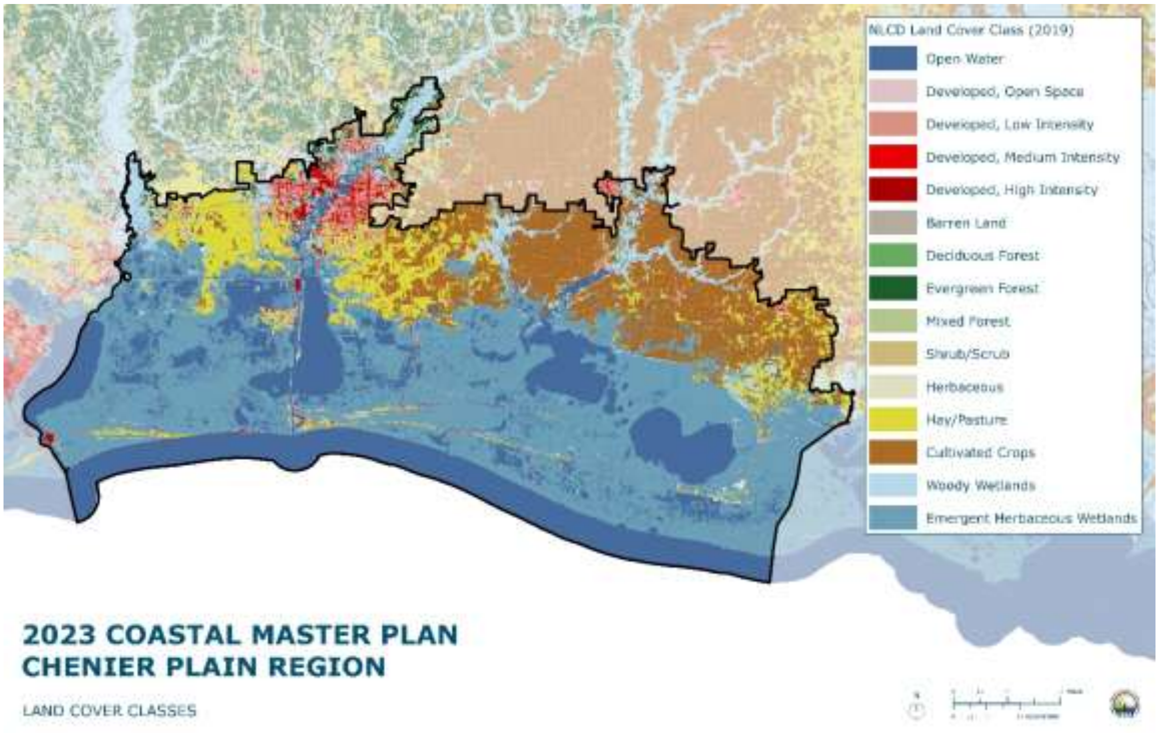

Figure 204. Land cover types in the Chenier Plain region.

POPULATION

The Chenier Plain region is comprised of two coastal basins: Calcasieu-Sabine and Mermentau. The southern portion of each basin consists of a system of estuarine lakes and coastal marshes interspersed with cheniers and isolated high ground while the northern portion consists of coastal prairies along the Pleistocene prairie terraces. This limited topographic elevation defines much of the human and cultural geography of the region.

CALCASIEU-SABINE BASIN

The Calcasieu-Sabine Basin, located in the western portion of the Chenier Plain region, includes Sabine Lake and Calcasieu Lake and an interlinked system of marshes, bayous, and canals between them. Cameron Parish, Louisiana's largest parish by land area, comprises the majority of the area of the basin. This is notably also the least populated parish in the state with 5,617 residents as of the time of the 2020 Census. While not densely populated, there are several population centers in the Lakes and Chenier sub-basins of the region. The majority of these are located along the chenier ridges, including the unincorporated communities of Hackberry, Johnson Bayou, Holly Beach, Cameron, Creole, Oak Grove, and Grand Chenier (Figure 205). North of the cheniers, the only population centers are those unincorporated communities along Calcasieu Lake, including Hackberry and Grand Lake.

As a result of several devastating hurricane strikes, Cameron Parish has seen a loss of nearly half of its population since 2005, when Hurricane Rita made landfall in Johnson Bayou. Rita's 18-foot storm surge flooded most of the structures in Cameron, Holly Beach, Hackberry, Creole, Johnson Bayou, and Grand Chenier. The community of Pecan Island in neighboring Vermilion Parish saw most of its structures destroyed. Three years later, Hurricane Ike brought a 22-foot storm surge that again flooded many of these same communities. In 2020, this area was struck by two devastating hurricanes only weeks apart. Hurricane Delta made landfall as a Category 2 storm near Creole, while Hurricane Laura made landfall to the east near Cameron.

Figure 205. Population density of communities located in the Chenier and Lakes sub-basins of the Chenier Plain region.

At the time of the 2020 Census, Grand Lake and Hackberry were the two largest communities in the lower portion of the Calcasieu-Sabine Basin (Table 12). This largely rural region does not contain a high number of minority residents, although the percentage of Indigenous residents in Cameron, Creole, and Grand Lake is at or slightly above the statewide average of 1.1%. Grand Lake also has a slightly higher percentage of Hispanic residents than the statewide average of 5.6%. Finally, with the exception of the town of Cameron, the proportion of residents of the Lakes and Chenier sub-basins in poverty is lower than the statewide average of 19.6% for each of the population centers examined.

Note that these population numbers may not account for the impacts of the 2020 Atlantic hurricane season, which included hurricanes Laura and Delta, which devastated the chenier communities of Cameron Parish. After Hurricane Laura, the in-person census count in the region was shut down for 5 weeks. Census workers had about three days to count on the ground before Hurricane Delta shut down the in-person counts.

Table 12. Demographics of communities comprising the Chenier and Lakes sub-basins of the Chenier Plain region

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
CAMERON	316	278	14	5	0	8	58
		88.0%	**4.4%**	**1.6%**	**0.0%**	**2.5%**	**29.4%**
CREOLE	281	247	23	3	0	7	0
		87.9%	**8.2%**	**1.1%**	**0.0%**	**2.5%**	**0.0%**
GRAND CHENIER	32	31	0	0	0	1	0
		96.9%	**0.0%**	**0.0%**	**0.0%**	**3.1%**	**0.0%**
GRAND LAKE	558	493	6	8	3	32	110
		88.4%	**1.1%**	**1.4%**	**0.5%**	**5.7%**	**14.7%**
HACKBERRY	877	842	0	5	1	22	131
		96.0%	**0.0%**	**0.6%**	**0.1%**	**2.5%**	**10.5%**
JOHNSON BAYOU	122	121	0	0	0	1	7
		99.2%	**0.0%**	**0.0%**	**0.0%**	**0.8%**	**7.4%**
PECAN ISLAND	61	59	0	0	0	1	3
		96.7%	**0.0%**	**0.0%**	**0.0%**	**1.6%**	**7.3%**

LAKE CHARLES METROPOLITAN AREA

The most heavily urbanized portion of the Calcasieu-Sabine Basin is located in Calcasieu Parish at the northern edge of the basin. This portion of the basin includes the incorporated cities of Lake Charles, Sulphur, and Westlake, which make up a large portion of the Lake Charles Metropolitical Area (Figure 206). This combined population of the area was 210,409 prior to the storm events of 2020.

The Lake Charles Metropolitan Area is home to the second largest concentration of petroleum and petrochemical refining activities in the state of Louisiana. As a result, both the regional economy and changes in population are closely linked to national and global fluctuations in the energy sector. Prior to the 2020 storms, Lake Charles was the fastest growing metropolitan area in the state for five straight years (Scott et al., 2019). This growth was primarily driven by industrial expansion and related job growth in the energy sector, including the development of a number of liquefied natural gas export facilities in the region.

While the city's proximity to the Gulf makes it vulnerable to the impacts of tropical weather events, flooding caused by storm surge is generally limited to the Calcasieu River and backwater areas of its tributaries. Channel overflow from rain runoff is the principal flood problem in the City of Lake Charles and other nearby cities like Sulphur. This risk profile has had a direct impact on the levels of outmigration following tropical storm events in the region. Unlike the communities of the Lakes and Chenier sub-basins in Cameron Parish, Lake Charles did not experience high levels of flooding after Hurricane Rita. Much of the damage was a result of wind impacts. As a result, homeowner's insurance was applicable to the damage and many of the impediments to rebuilding due to standing flood waters did not exist in Lake Charles allowing residents to return and rebuild fairly quickly after the storm (Scott et al., 2019).

The impacts of hurricanes Laura and Delta in 2020 are yet to be fully accounted for. Initial reporting suggests that population in the Lake Charles Metropolitan Area has not been as quick to recover from the impacts of these hurricanes as from previous storms. Prior to the storms, five years of job growth created a housing crisis in the region. The combination of this pre-existing housing crisis, the ongoing COVID-19 pandemic, and the two hurricanes resulted in the highest levels of outmigration in the nation from 2019 to 2020 (Berlin, 2021).

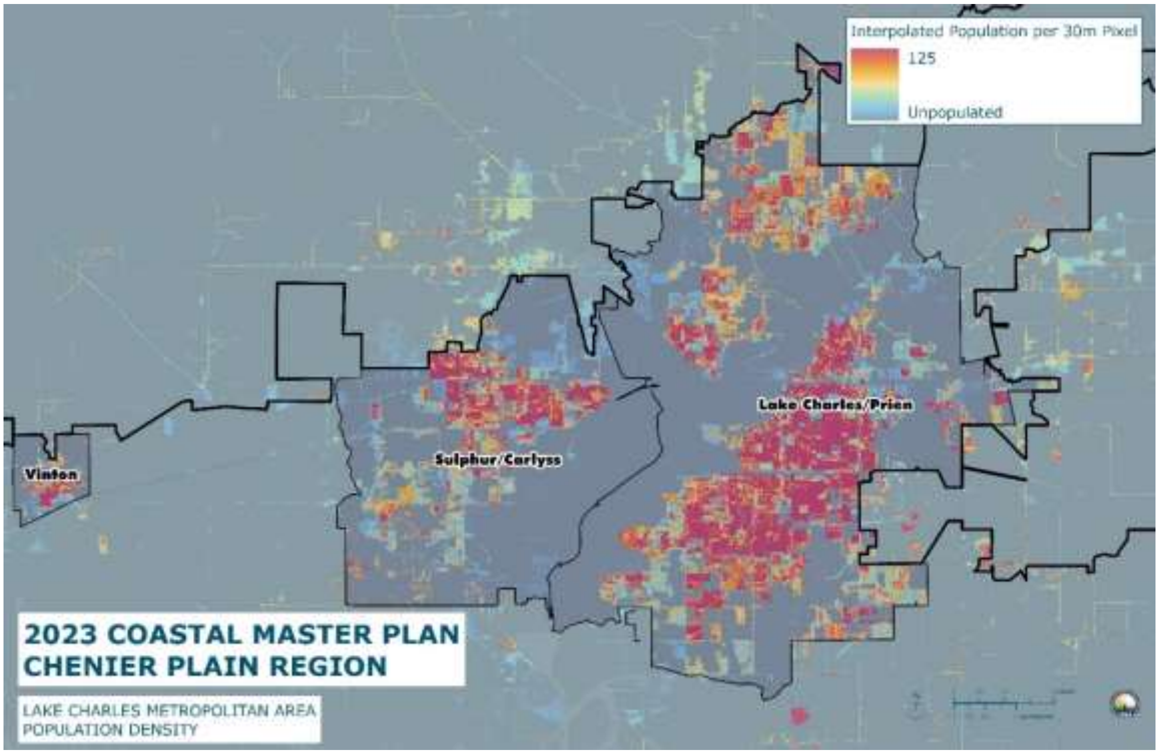

Figure 206. Population density of communities comprising the Lake Charles Metropolitan Area.

The demographic profile of Lake Charles is similar to that of the state overall. The white population is below the state average of 62.4%, while the Black and Asian populations are slightly above average (Table 13). Outside of Lake Charles, in Sulphur and Carlyss, the percentage of minority residents is generally well below the state average. Finally, the proportion of residents of Lake Charles and Sulphur in poverty is lower than the statewide average of 19.6%, while the smaller community of Vinton, located to the west of the region's urban core, has over a quarter of its population below the poverty level.

Table 13. Demographics of communities located in the Lake Charles Metropolitan Area

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
LAKE CHARLES/ PRIEN	137,114	75,398	47,032	607	3,117	7,450	21,967
		55.0%	**34.3%**	**0.4%**	**2.3%**	**5.4%**	**17.7%**
SULPHUR/CARLYSS	33,594	27,656	2,397	195	464	2,149	3,836
		82.3%	**7.1%**	**0.6%**	**1.4%**	**6.4%**	**11.9%**
VINTON	3,384	2,306	672	34	26	287	882
		68.1%	**19.9%**	**1.0%**	**0.8%**	**8.5%**	**27.5%**

NORTHERN MERMENTAU BASIN

Much of the Mermentau Basin north of the GIWW includes a mixture of agricultural, industrial, and undeveloped land and includes communities in Acadia, Jefferson Davis, and Acadia parishes. The primary economic activities that support the towns and cities of the area include agriculture, support services for offshore oil exploration and production activities, and tourism. Agriculture is the dominant land use of the area and includes a mixture of rice, sugarcane, soybeans, cotton, corn, and beef cattle. Much of the undeveloped land in the region is classified as coastal prairie, which transitions to coastal marsh to the south. Much of the marshland of the area is used for natural resource-related activities such as fishing, trapping, mining, and oil production. Most incorporated and unincorporated communities atop the Pleistocene prairie terraces have developed along major highways and railroads, with most commercial development occurring in or around these areas (Figure 207). Rainfall-induced flooding has historically been the primary source of flood risk to many of these communities, often with accompanying backwater flooding.

Figure 207. Population density of communities located in the northern Mermentau Basin.

The communities in the northern Mermentau Basin are principally rural and agricultural. In general, the towns and small cites of the area do not have minority populations significantly higher than the state average (Table 14). Each of the communities examined, apart from Morse, have levels of poverty that are notably higher than the statewide average of 19.6%.

Table 14. Demographics of Communities located in the northern Mermentau Basin

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
ABBEVILLE	16,017	8,622	5,409	60	829	767	4,179
		53.8%	**33.8%**	**0.4%**	**5.2%**	**4.8%**	**23.7%**
GUEYDAN	1,318	1,120	157	0	1	25	313
		85.0%	**11.9%**	**0.0%**	**0.1%**	**1.9%**	**24.7%**
HAYES	678	636	11	4	0	21	200
		93.8%	**1.6%**	**0.6%**	**0.0%**	**3.1%**	**35.1%**
INTRACOASTAL CITY	33	25	6	0	0	2	14

COMMUNITY	TOTAL POPULATION	WHITE	BLACK	INDIGENOUS	ASIAN	HISPANIC	BELOW POVERTY LEVEL
		75.8%	**18.2%**	**0.0%**	**0.0%**	**6.1%**	**32.6%**
JENNINGS	9,671	6,390	2,662	39	37	242	2,007
		66.1%	**27.5%**	**0.4%**	**0.4%**	**2.5%**	**21.5%**
KAPLAN	4,714	3,754	622	15	45	132	1,040
		79.6%	**13.2%**	**0.3%**	**1.0%**	**2.8%**	**21.4%**
LAKE ARTHUR	2,979	2,512	308	2	2	41	799
		84.3%	**10.3%**	**0.1%**	**0.1%**	**1.4%**	**27.7%**
MERMENTAU	516	407	72	2	0	8	147
		78.9%	**14.0%**	**0.4%**	**0.0%**	**1.6%**	**25.3%**
MORSE	130	129	0	0	0	0	62
		99.2%	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**18.2%**

6.2 SUMMARY OF RISK

This section summarizes the simulation modeling results projecting coastal flood risk and damage for the Chenier Plain region over a 50-year period in a FWOA scenario. This includes projected storm surge and wave heights, flood depths, exposure of single-family residences, and flood damage. Model results show that the locations expected to experience the greatest increase in storm surge are generally in the largely unpopulated marshes surrounding Grand Lake and White Lake, inland from the populated chenier communities. The low population density of the region will likely result in lower total flood exposure and damage dollars for the chenier communities despite the increasing levels of risk. Storm 471 is used to describe impacts within this region. Storm 471 makes landfall with a slight negative angle west of Lake Calcasieu. Surge is pushed against the coastal chenier ridges and then flows across the relatively low gradient topography of the Chenier Plain.

STORM SURGE AND WAVES

In the latter half of the 50 period of analysis, ICM results show relatively little subsidence across the Chenier Plain region, particularly in the Calcasieu-Sabine Basin. The wetlands and marshes in the Chenier Plain are expected to experience an increase in topographic elevation resulting in increased wind and water friction. This includes the low elevation land between the chenier ridges and around the many estuarine lakes further inland. The increased friction and topographic values in the wetlands are expected to minimize the ability of storm surge to move inland. This anticipated change in elevation is found under both the lower and higher environmental scenarios.

Due to the relatively low gradient topography present in the Lakes and Chenier sub-basins, surge levels immediately offshore are generally lower than the SLR increment used in the lower environmental scenario. As a result, surge amplification on the floodplain is relatively uniform across the area. Despite the anticipated change in topographic elevation, in Year 30 and Year 50, the floodplain still shows inland expansion over the present-day floodplain, with an expected increase in both water depth and wave heights. However, under the lower scenario, these increases are expected to be minimal in the areas around the chenier communities through Year 30. By Year 50, the floodplain is expected to expand into these areas, though the increase in water depth and wave height will be relatively small.

In the higher scenario, however, the increased rate of SLR shows significant amplification in the surge levels, particularly in the wetland areas around Grand and White Lake. In Year 30, surge levels increase 3-4 feet, but by Year 50, peak water surface elevations increase 7-9 feet. These changes come with a significant expansion of the floodplain and increased wave heights due to the increased water depth. The locations expected to experience the greatest increase in both water depth and wave height, however, are generally inland from the chenier communities, in the largely unpopulated marshes surrounding the estuarine lakes of the region.

FLOOD DEPTH AND DAMAGE

The low population density of the region, particularly in the chenier communities and those located near Calcasieu Lake, such as Hackberry and Grand Lake, will result in lower total flood exposure and damage dollars for these communities, despite the increasing levels of risk. CLARA simulations for the Chenier Plain region show increases in both the extent and magnitude of flooding over the 50-year period of analysis under both environmental scenarios. These increases are generally linear over time in the lower environmental scenario, while they accelerate over the last two decades on the period of analysis in the higher scenario. This acceleration is primarily driven by differences in modeled SLR, with higher levels of SLR resulting in deeper and more widespread flooding.

Under both scenarios, higher flood depths occur in the Lakes and Chenier sub-basins. These sub-basins contain several estuarine lakes including Sabine, Calcasieu, Grand, and White. CLARA simulations find that flooding tends to be concentrated in areas along these lakes, especially to the north of White Lake, in the southeastern corner of the region. Notably, the area to the north of White Lake contains the White Lake Wetlands Conservation Area and is largely unpopulated. The northern portion of the region is expected to initially experience a small amount of inundation under the modeled storm scenario. Over time, however, model results show the floodplain steadily extending further inland to the east of Sabine Lake and the north of Calcasieu Lake, encroaching on populated communities such as Hackberry and Grand Lake, and even as far inland as Lake Charles. In the higher scenario, this expansion is faster and ranges wider across this region.

The areas with exposure to flooding and economic damage generally follow the spatial pattern of the flood depth simulations. CLARA simulations show that economic damage increases more linearly in the early decades but with a much higher acceleration rate in the last two decades of the 50-year period of analysis (Figure 208). In the higher scenario, flood damages increase quicker than in the lower scenario. CLARA results similarly show that the percentage of structures expected to experience moderate to high exposure increases over time, with many expected to experience severe exposure by Year 50. The assumptions related to SLR acceleration rates in these two environmental scenarios is likely the primary driver.

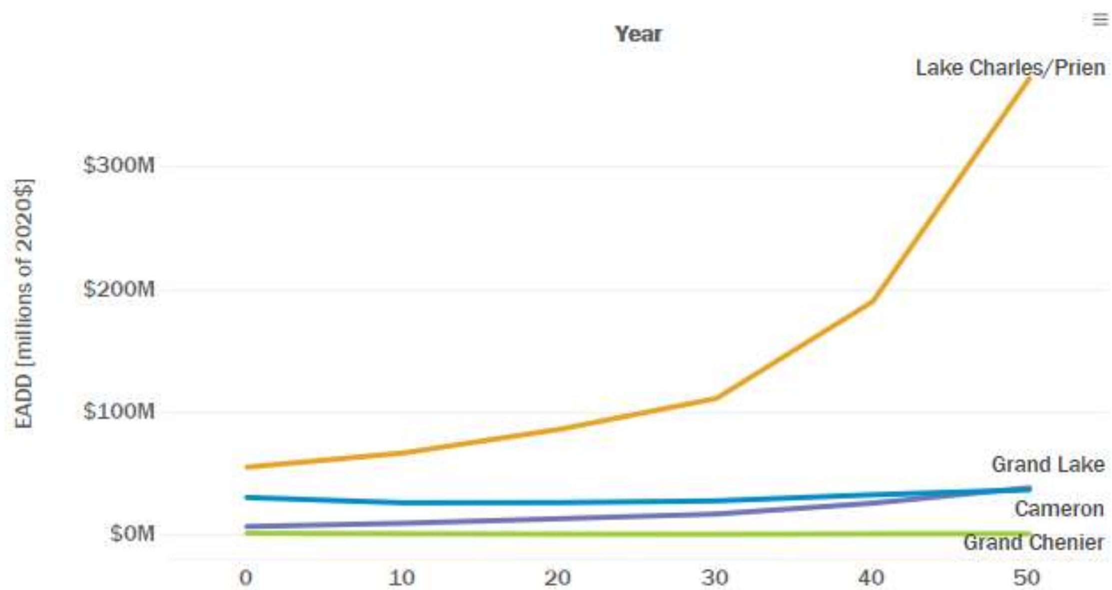

Figure 208. EADD in selected Chenier Plain region communities over the 50-year simulation period under the higher scenario.

The communities proximate to the estuarine lakes, including Hackberry and Grand Lake, face greater risk over time. The chenier communities similarly face increasing risk over time under both environmental scenarios. In the lower scenario, a larger portion of the southern part of the Chenier Plain region experiences a decline in economic damages over the period of analysis, but this portion shrinks only to the southern margin of Cameron in the higher scenario. It is important to note that the communities located in the Lakes and Chenier sub-basins are sparsely populated. As a result, economic risk is relatively low. By contrast, Lake Charles is expected to experience less flooding than the lake and chenier communities located in the southern portion of the region. However, the Lake Charles Metropolitan Area contains the largest concentration of population in the Chenier Plain region; thus, the expected economic risks are much higher.

6.3 STORM SURGE AND WAVES RESULTS

Topography and bathymetry are shown in Figure 209. Additionally, initial conditions land use was interpolated to the model to construct Manning's n (Figure 210), directional wind reduction (Figure 211), and surface canopy coefficients (Figure 212). Updated data is interpolated to the ADCIRC model from the ICM every 10 years. This section shows how the model changes in Year 30 and Year 50 and the associated simulation results.

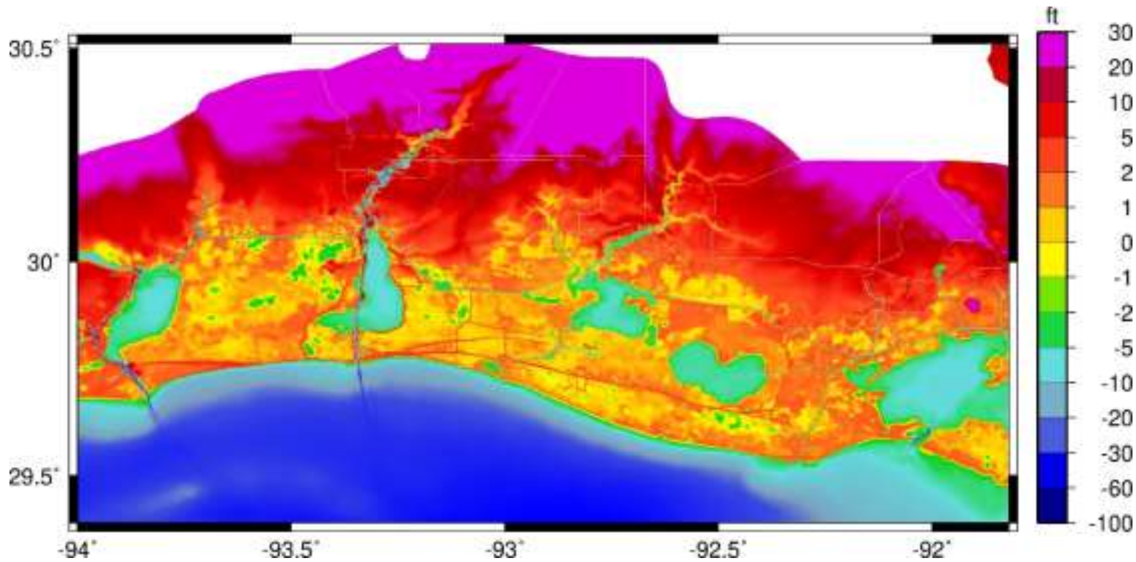

Figure 209. Topography and bathymetry (feet, NAVD88) in ADCIRC at Year 0.

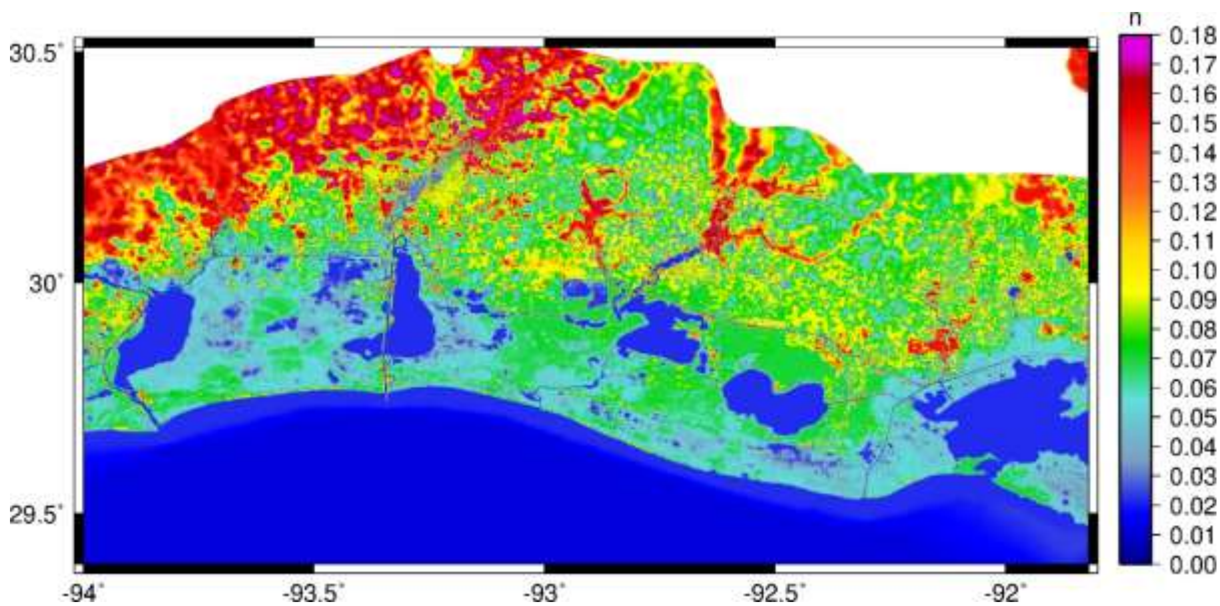

Figure 210. Manning’s n coefficient in ADCIRC at Year 0.

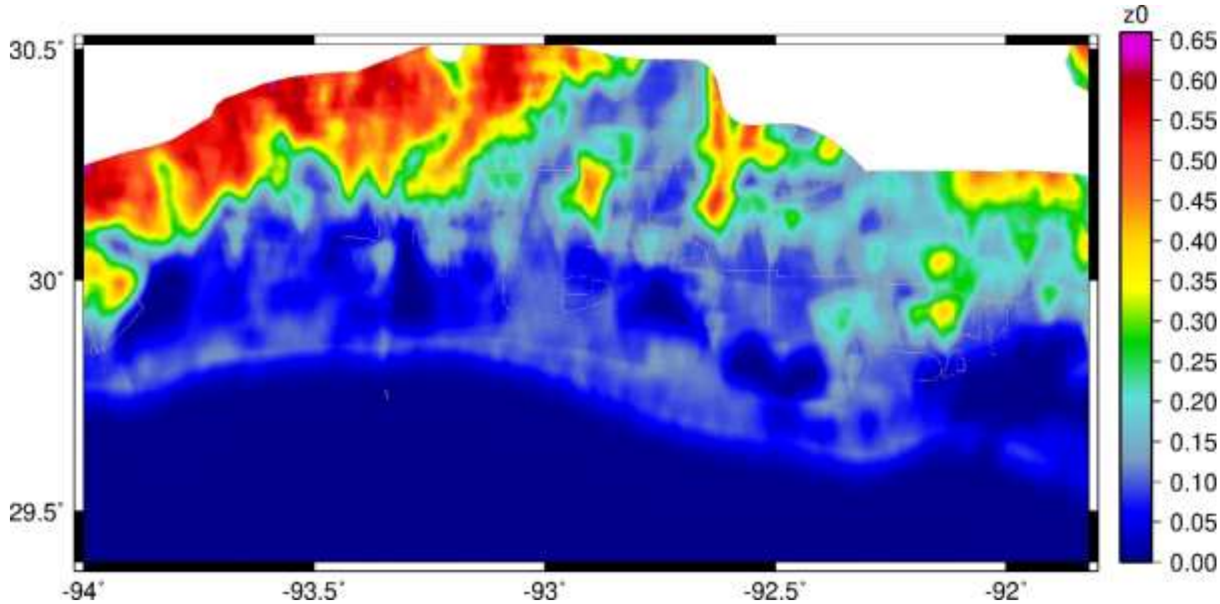

Figure 211. Directional wind reduction coefficient for a wind blowing from the south in ADCIRC at Year 0.

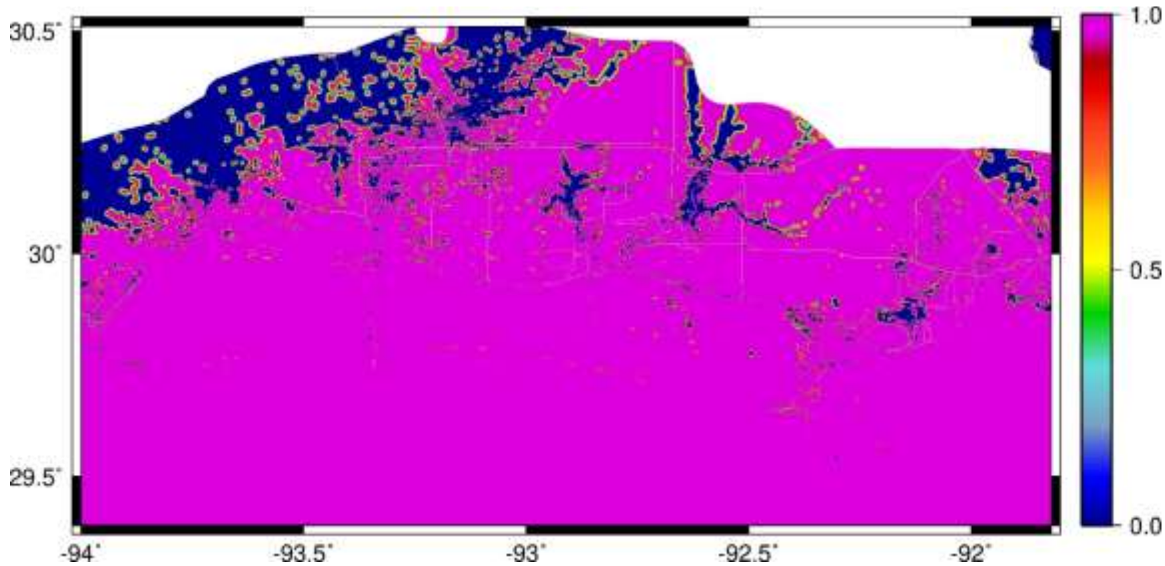

Figure 212. Surface canopy coefficient in ADCIRC at Year 0.

Storm 471 is used to describe impacts within this basin. Storm 471 makes landfall with a slight negative angle west of Lake Calcasieu. Surge is pushed against the coastal ridges in the region and then flows across the low gradient Chenier Plain. The peak surge elevation and peak wave height in Year 0 for Storm 471 is shown in Figure 213 and Figure 214

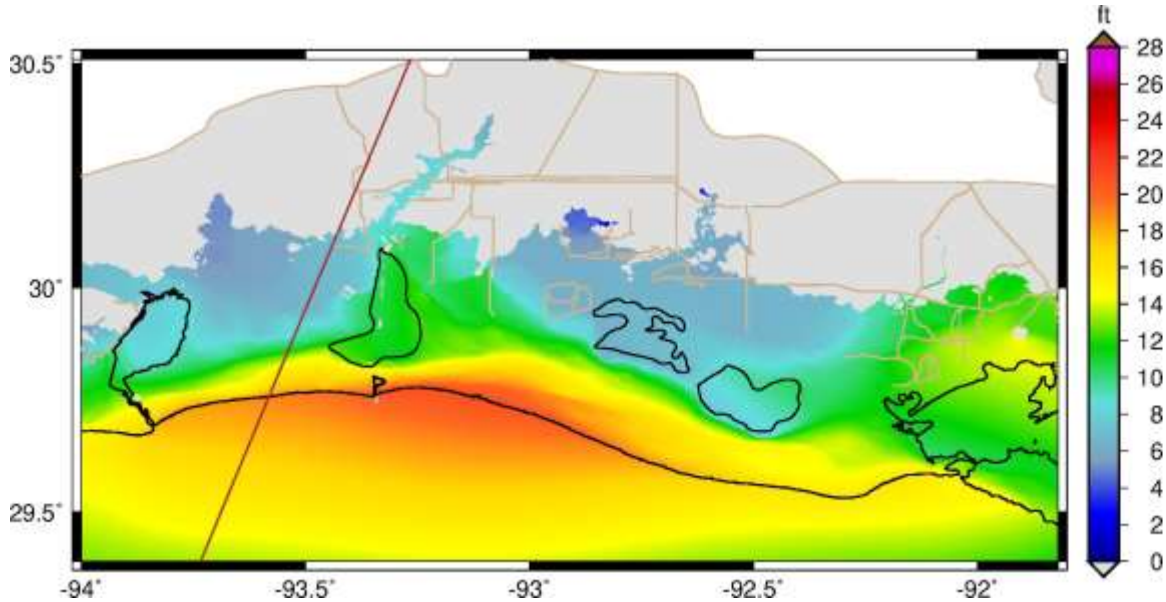

Figure 213. Peak water surface elevation for Storm 471 simulated in Year 0.

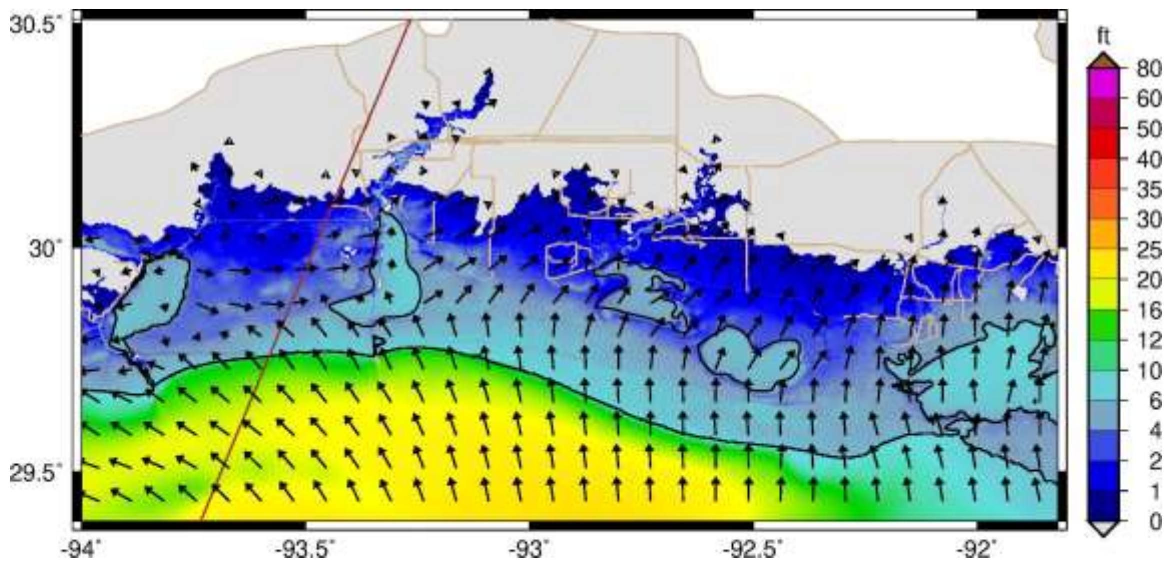

Figure 214. Peak wave height (feet) for Storm 471 in Year 0.

LOWER SCENARIO

In Year 30 and Year 50, the topographic elevations (Figure 215 and Figure 218) provided by the ICM generally change mostly in the marshy areas of the model with relatively little subsidence further west. Changes in frictional coefficients are mostly related to these changes in marsh characteristics (Figure 216, Figure 217, Figure 219, and Figure 220). Additional details about the changes in topography, bathymetry, and land use characteristics can be found in White et al. (2023).

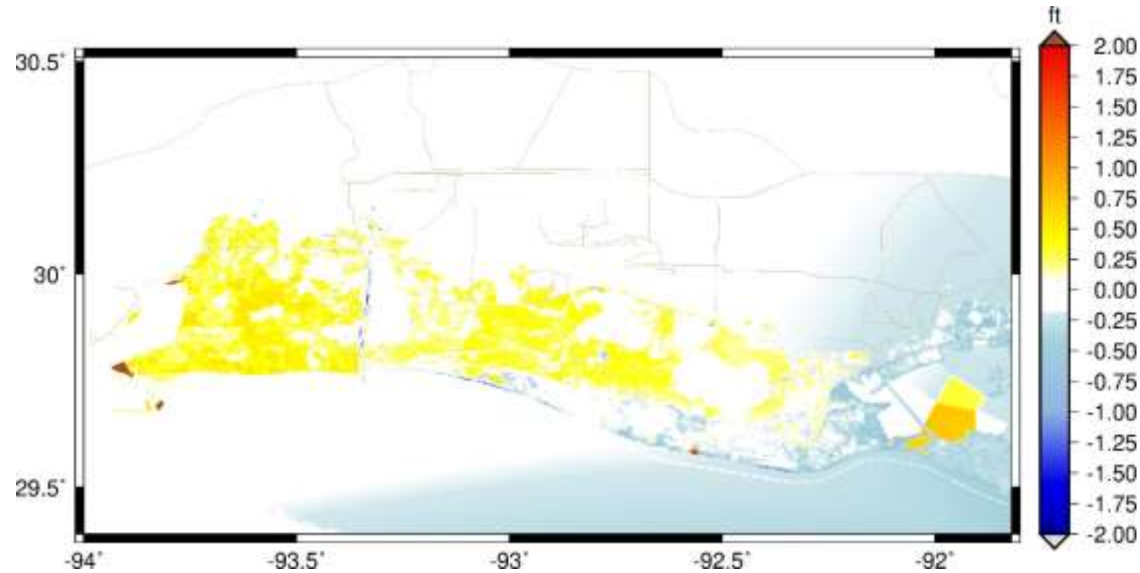

Figure 215. Change in topography and bathymetry in ADCIRC in the lower scenario for Year 30.

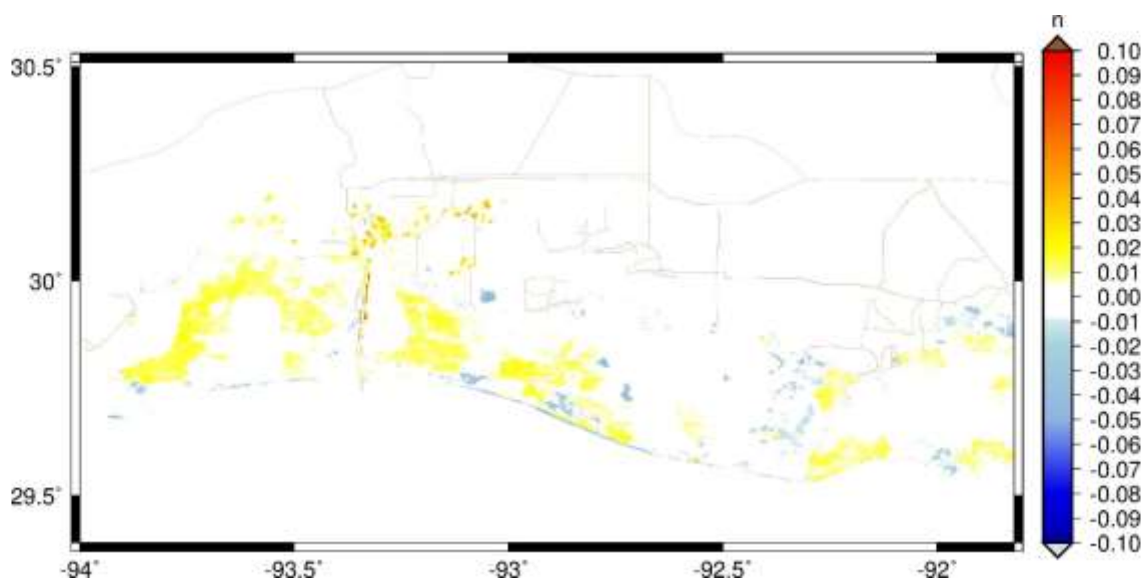

Figure 216. Change in Manning’s n in ADCIRC in the lower scenario for Year 30.

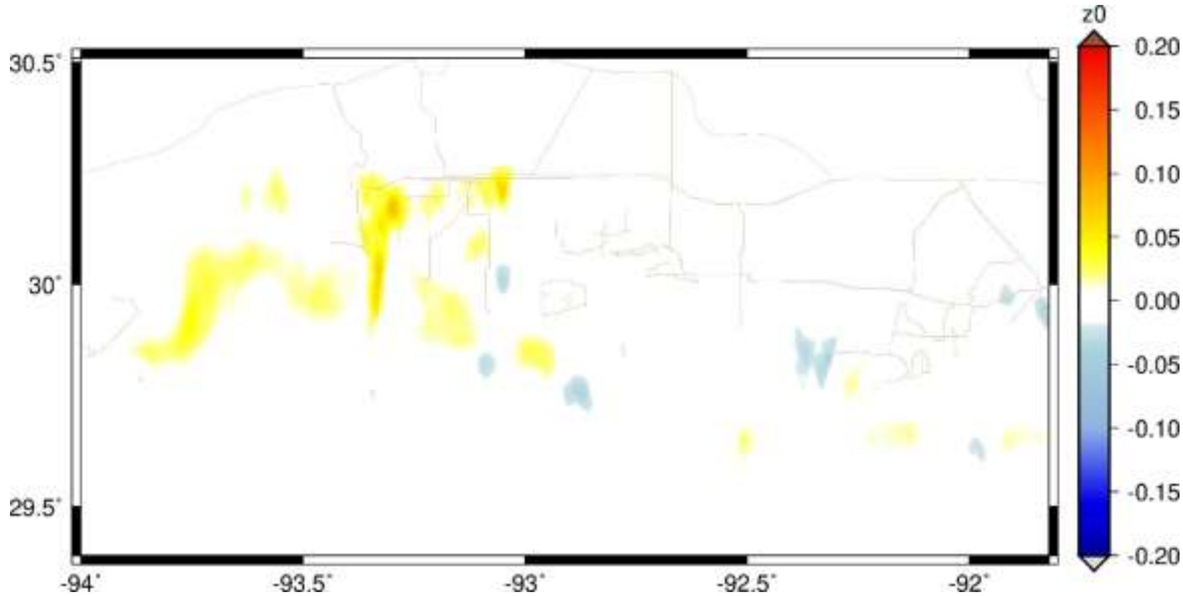

Figure 217. Change in directional wind reduction in ADCIRC in the lower scenario for Year 30.

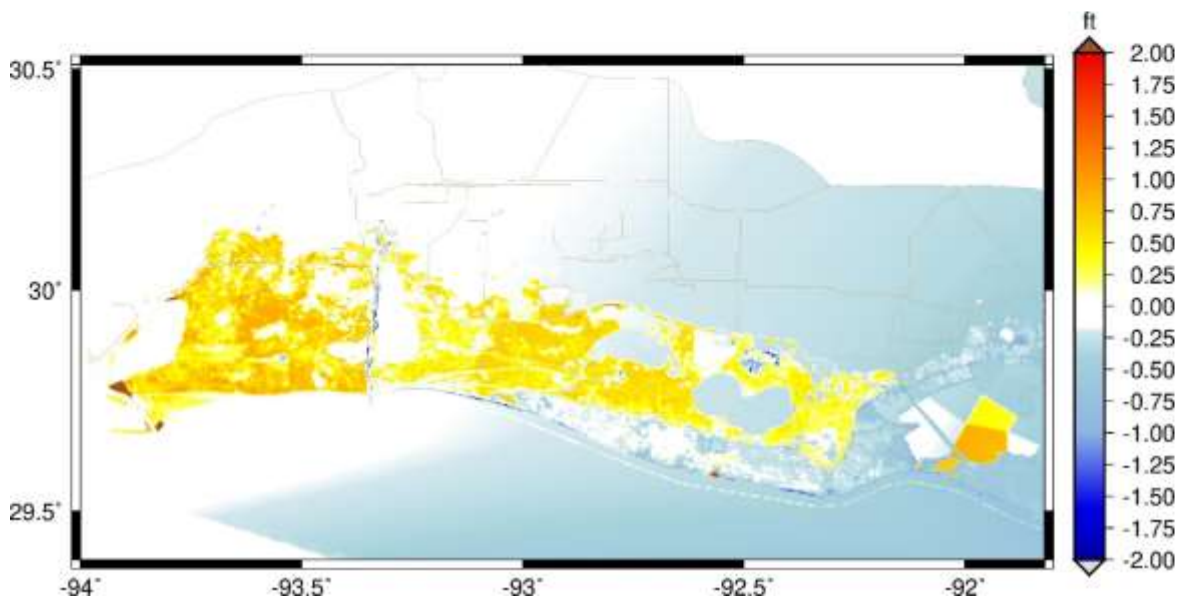

Figure 218. Change in topography and bathymetry in ADCIRC in the lower scenario for Year 50.

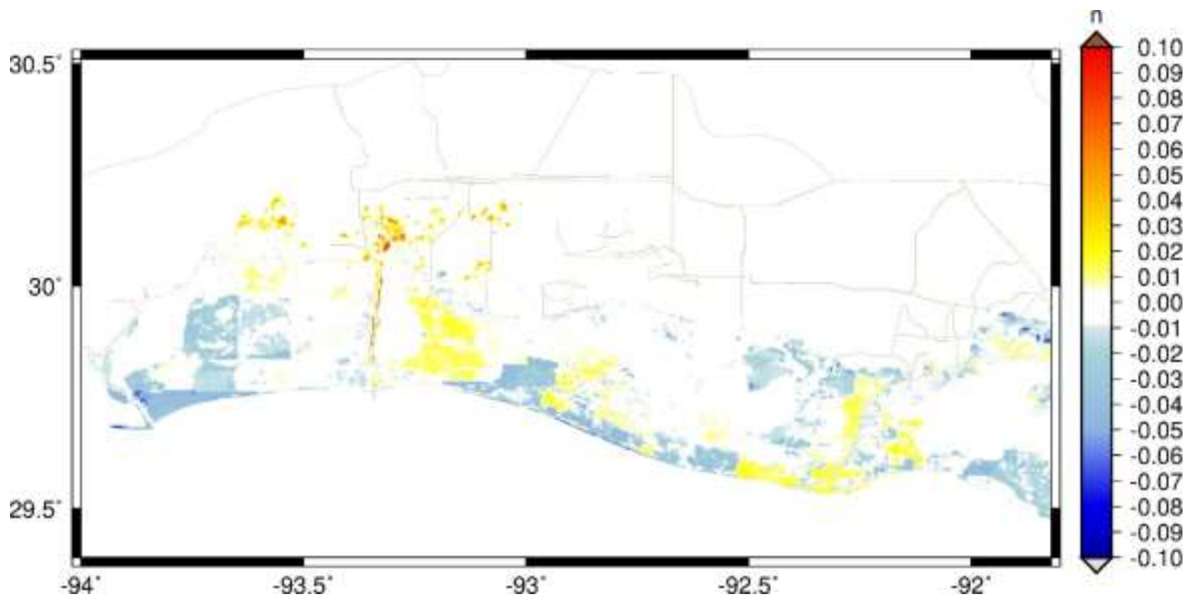

Figure 219. Change in Manning's n in ADCIRC in the lower scenario for Year 50.

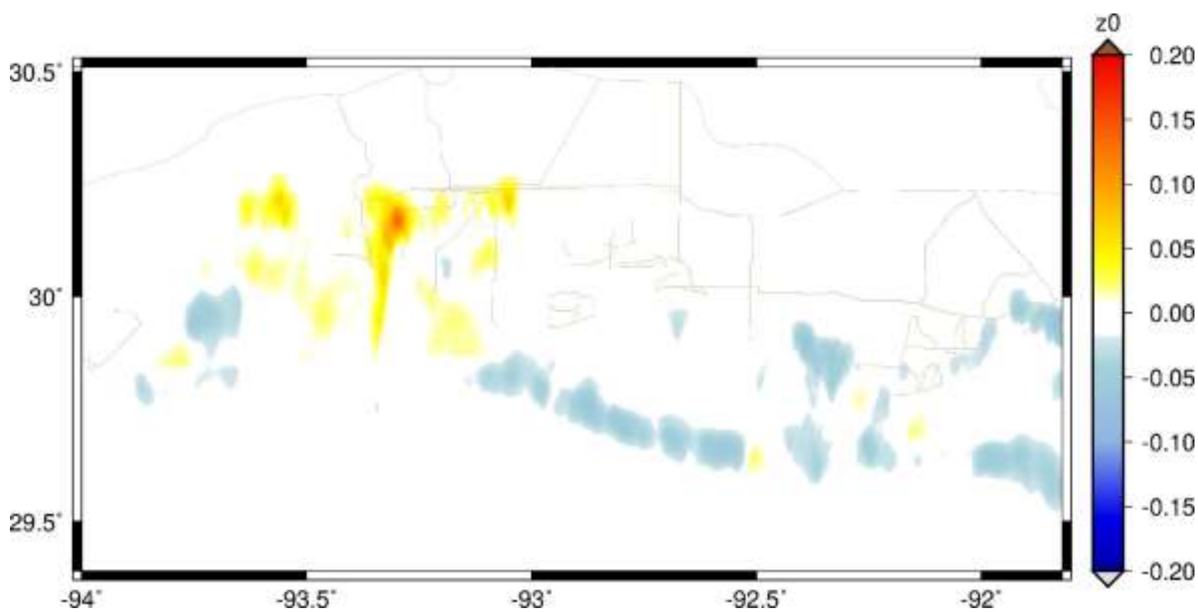

Figure 220. Change in directional wind reduction in ADCIRC in the lower scenario for Year 50.

Surge levels immediately offshore are generally lower than the SLR increment used, and surge amplification (Figure 221, Figure 223) on the floodplain is relatively uniform because of the low gradient topography. Near the edges of the floodplain, the brown areas denote areas where the floodplain has expanded during this storm. In both Year 30 and Year 50, the floodplain shows inland expansion. Wave heights increase due to the increase in water depth (Figure 222, Figure 224).

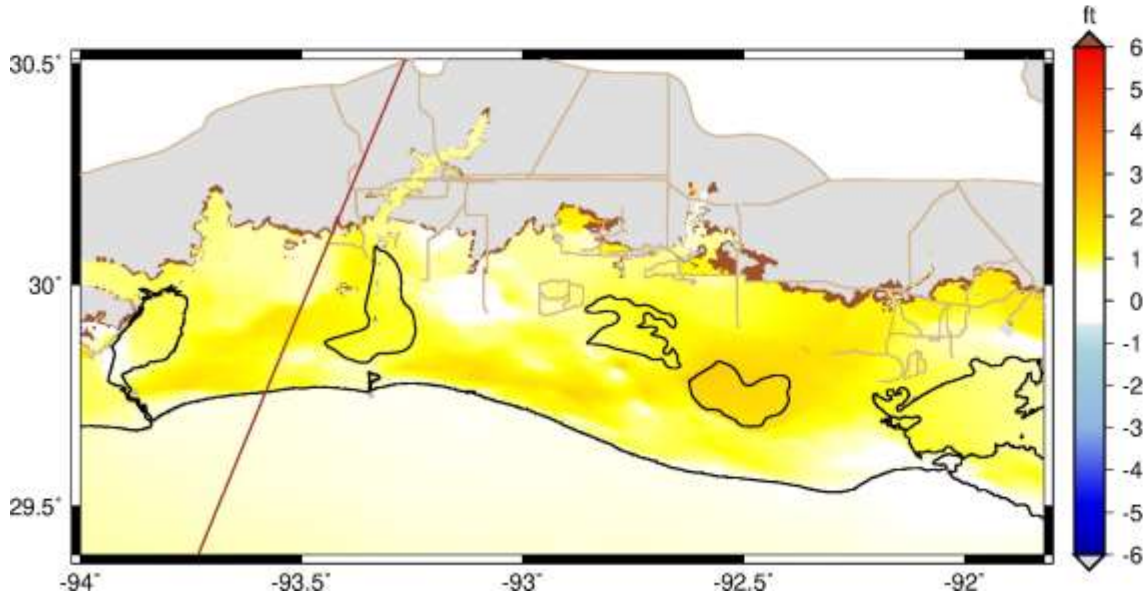

Figure 221. Change in peak water surface elevation between Year 30 and Year 0 in the lower scenario.

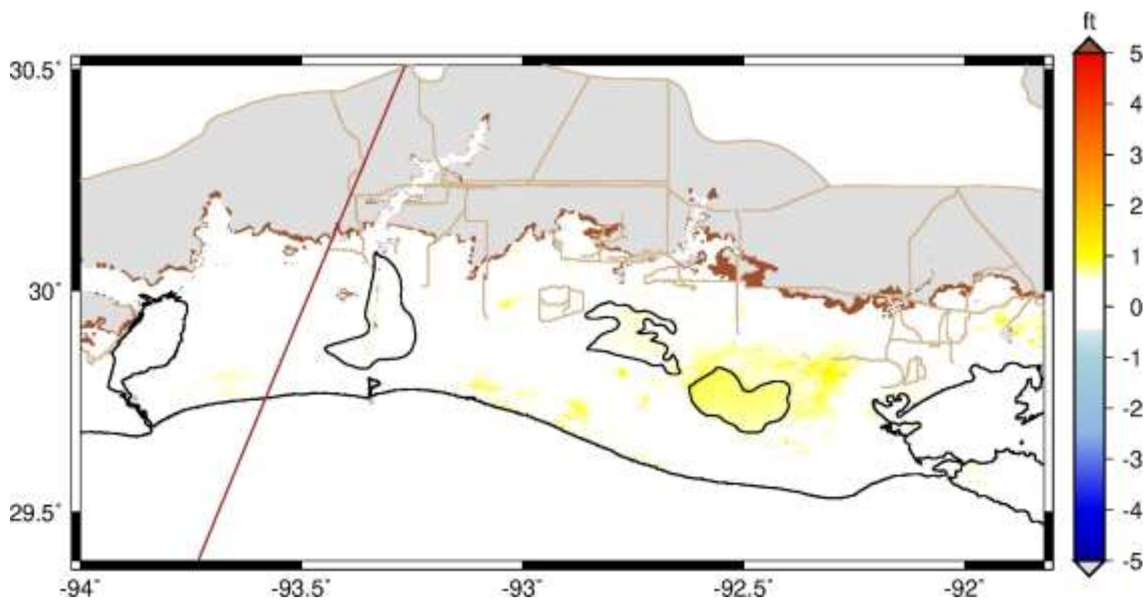

Figure 222. Change in peak wave height between Year 30 and Year 0 in the lower scenario.

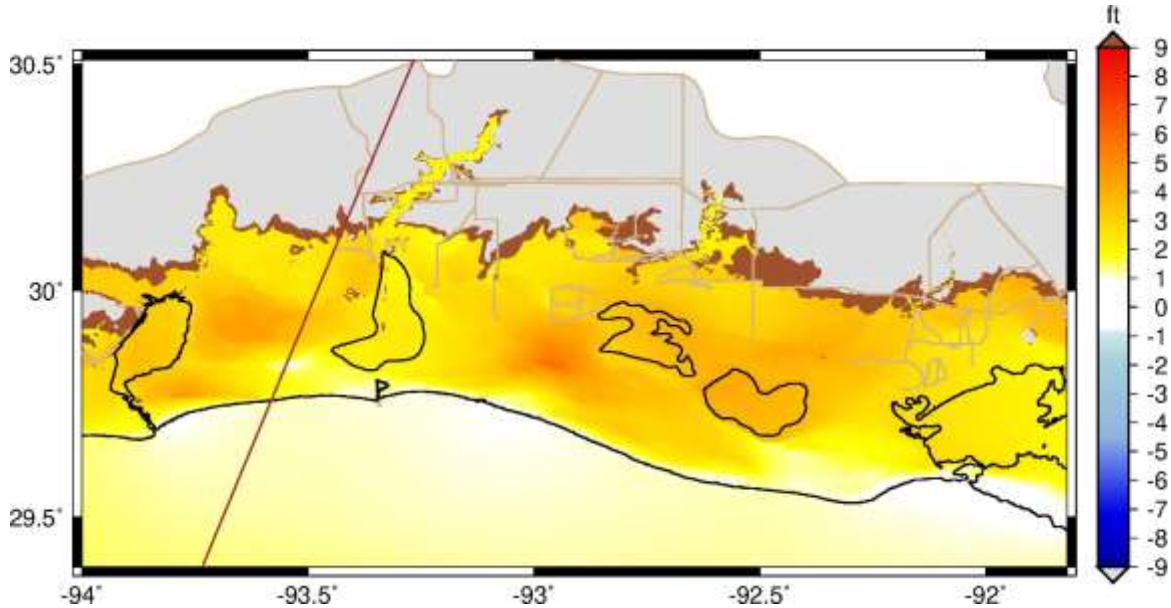

Figure 223. Change in peak water surface elevation between Year 50 and Year 0 in the lower scenario.

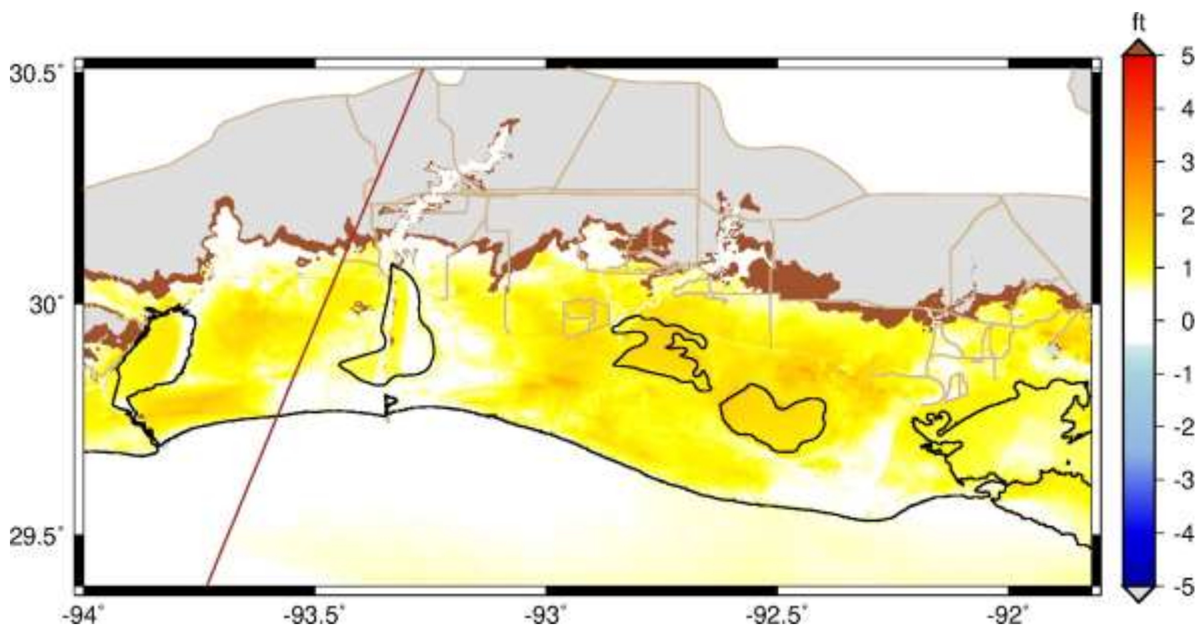

Figure 224. Change in peak wave height between Year 50 and Year 0 in the lower scenario.

HIGHER SCENARIO

In Year 30 and Year 50, the topographic elevations (Figure 225 and Figure 228) provided by the ICM generally change mostly in the marshy areas of the model with relatively little subsidence further west. Changes in frictional coefficients are mostly related to these changes in marsh characteristics (Figure 226, Figure 227, Figure 229, and Figure 230). Additional details about the changes in topography, bathymetry, and land use characteristics can be found in White et al. (2023).

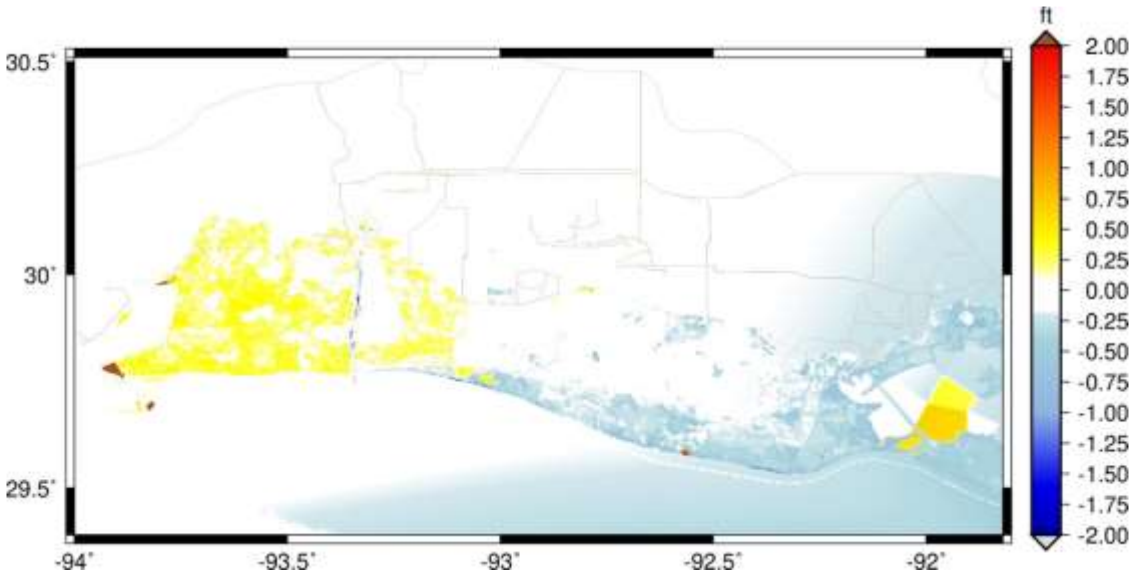

Figure 225. Change in topography and bathymetry in ADCIRC in the higher scenario for Year 30.

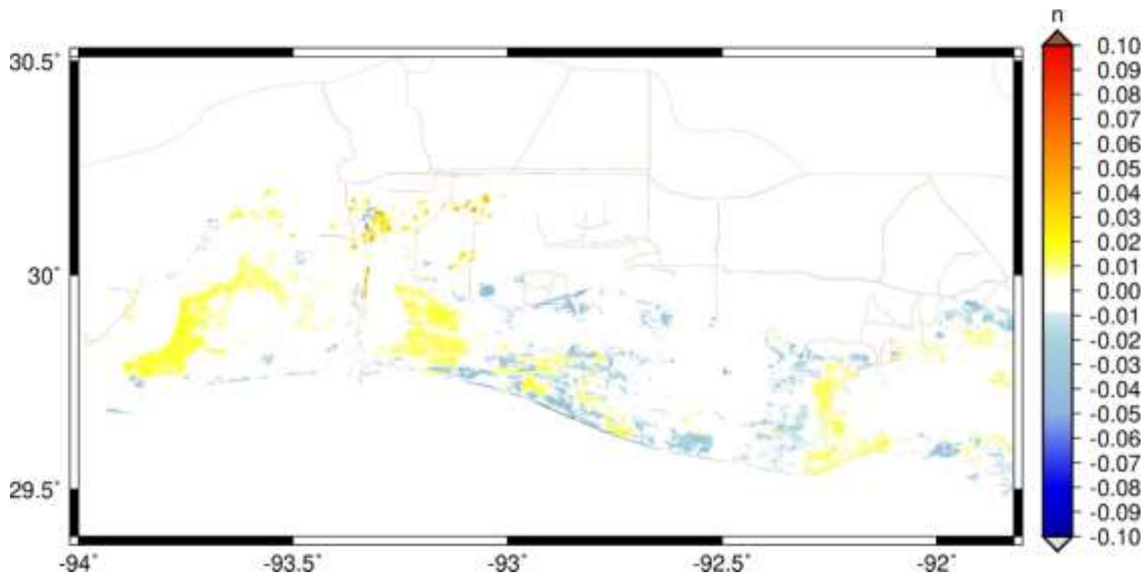

Figure 226. Change in Manning's n in ADCIRC in the higher scenario for Year 30.

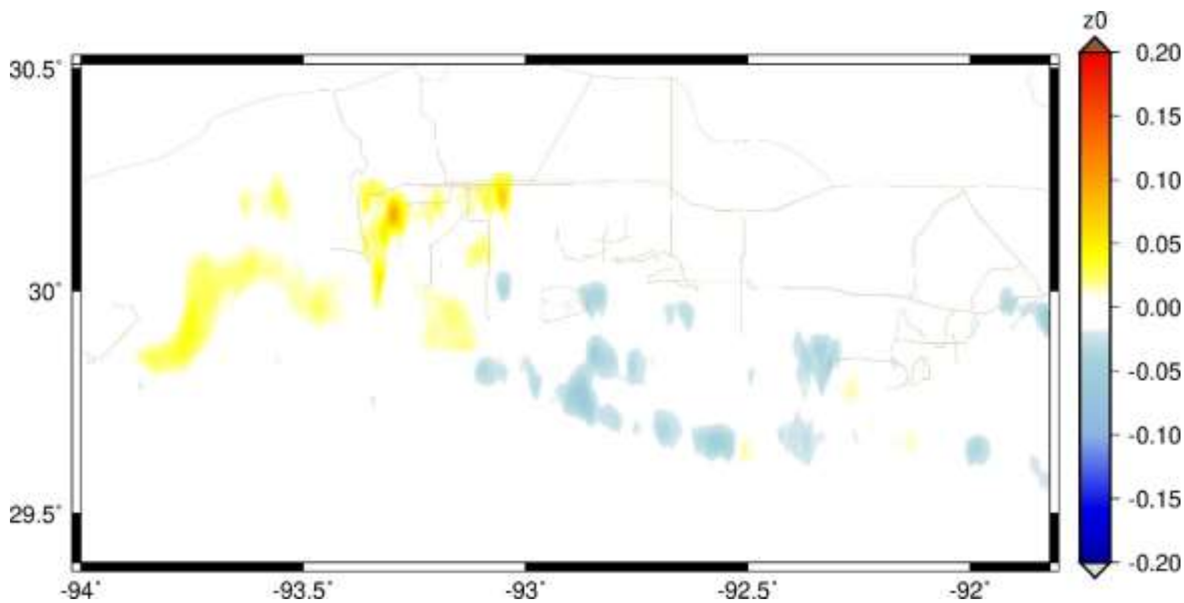

Figure 227. Change in directional wind reduction in ADCIRC in the higher scenario for Year 30.

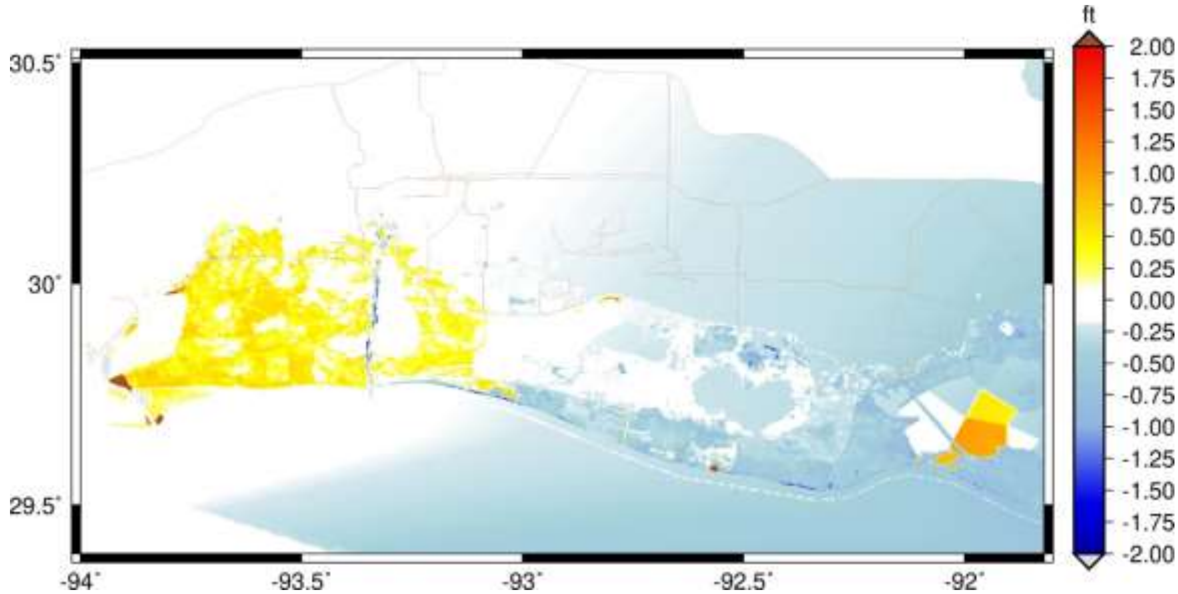

Figure 228. Change in topography and bathymetry in ADCIRC in the higher scenario for Year 50.

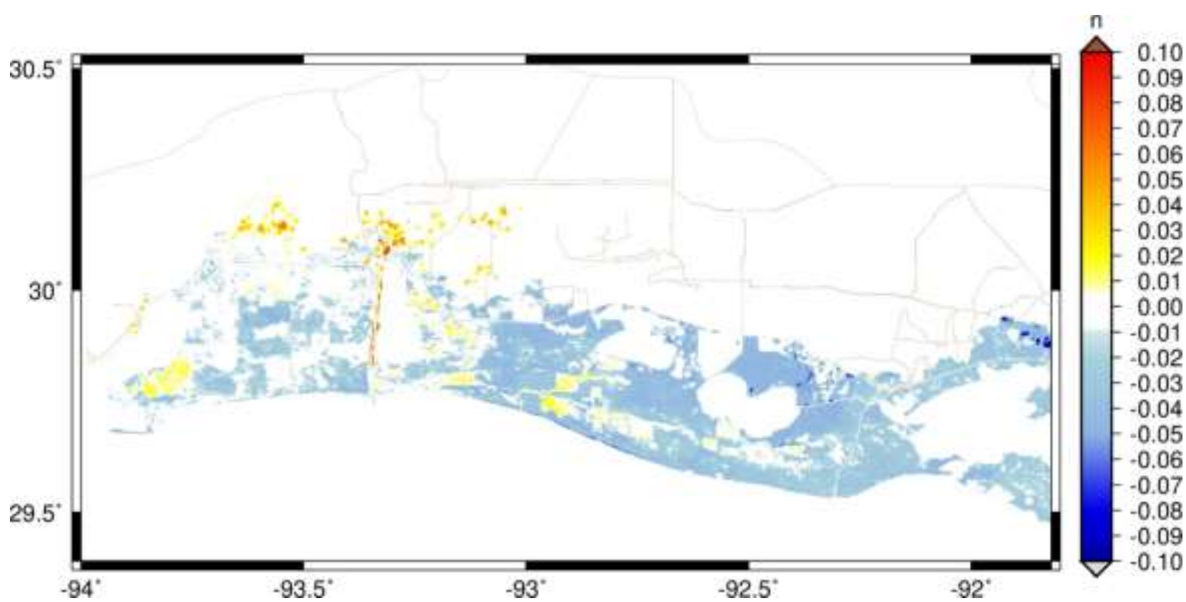

Figure 229. Change in Manning's n in ADCIRC in the higher scenario for Year 50.

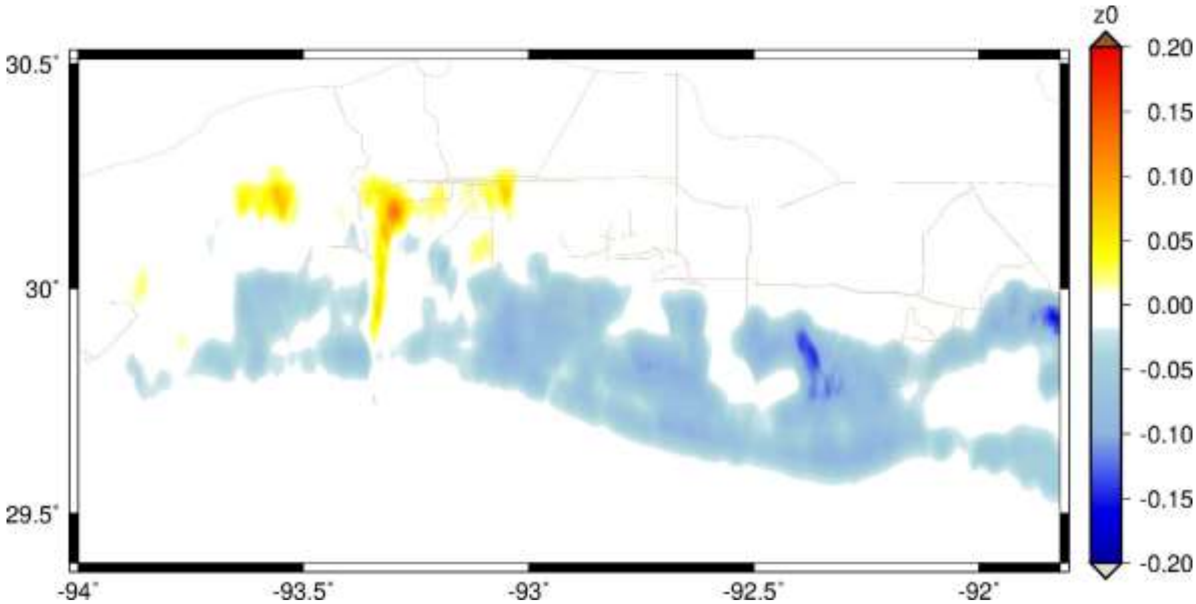

Figure 230. Change in directional wind reduction in ADCIRC in the higher scenario for Year 50.

In the higher scenario, the increased rate of SLR shows significant amplification in the surge levels (Figure 231, Figure 233), particularly near Grand and White lakes. In Year 30, surge levels increase 3-4 feet, but by Year 50, peak water surface elevations increase 7-9 feet. These changes come with a significant expansion of the floodplain and increased wave heights (Figure 232, Figure 234) due to the increased depth.

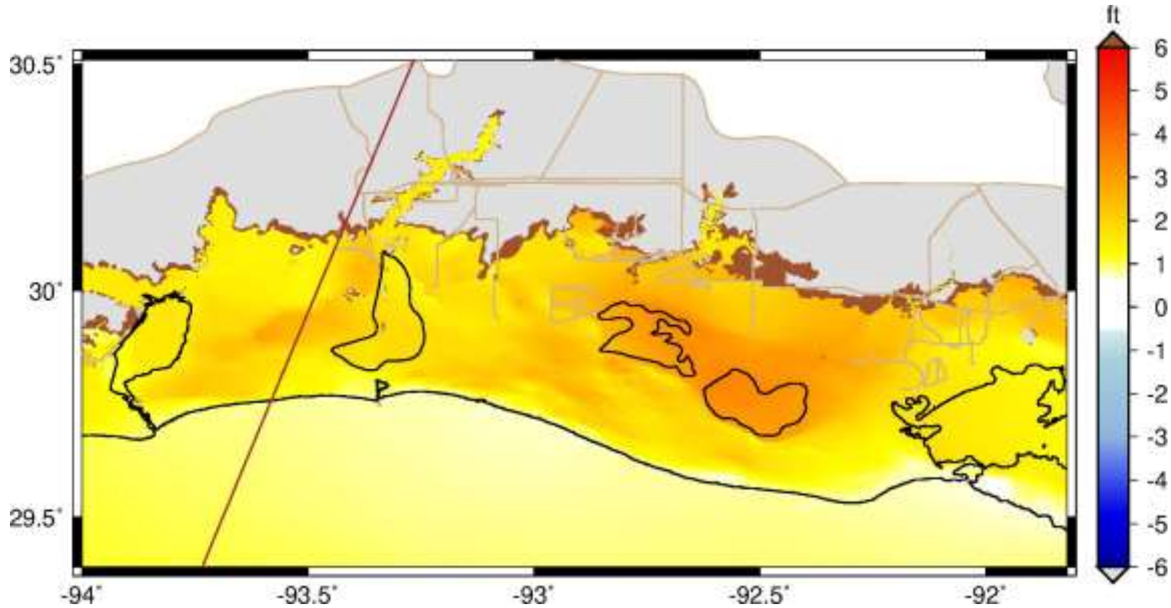

Figure 231. Change in peak water surface elevation between Year 30 and Year 0 in the higher scenario.

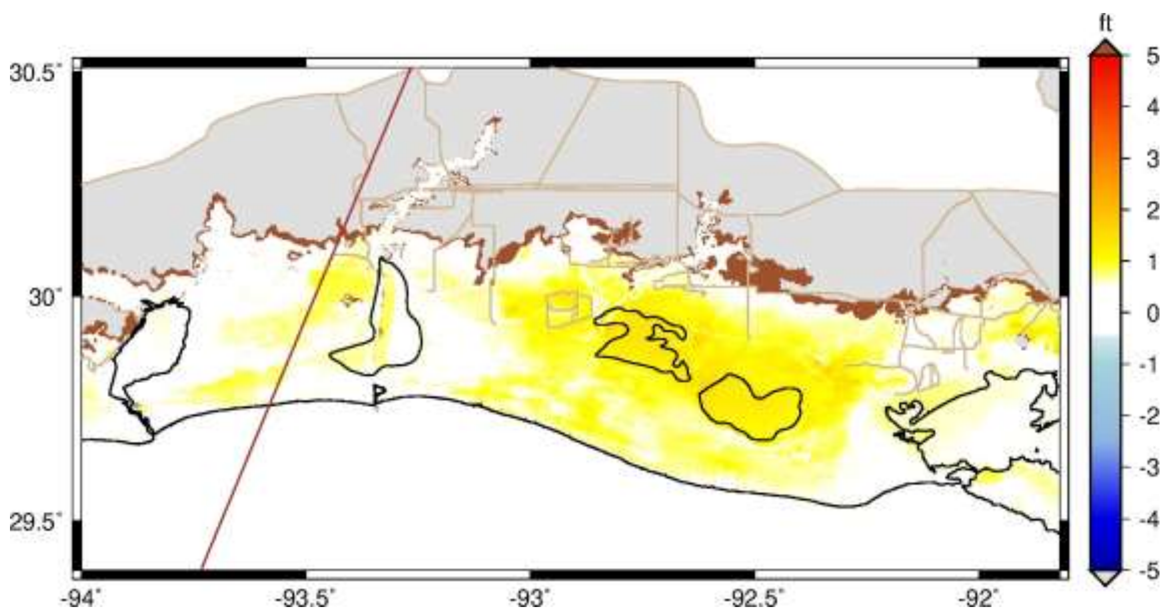

Figure 232. Change in peak wave height between Year 30 and Year 0 in the higher scenario.

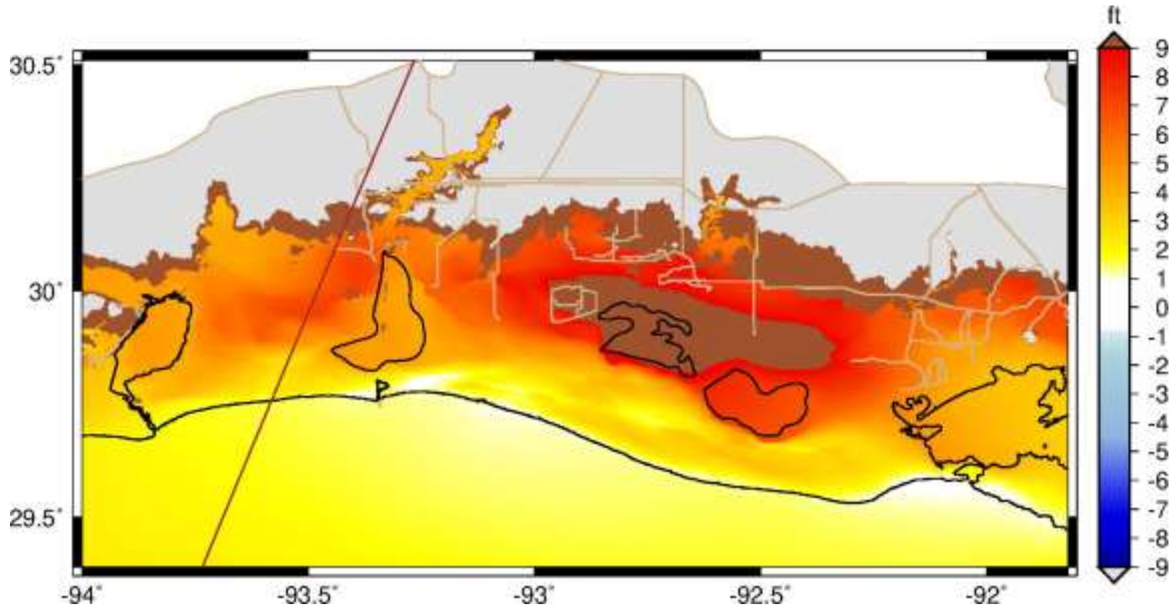

Figure 233. Change in peak water surface elevation between Year 50 and Year 0 in the higher scenario.

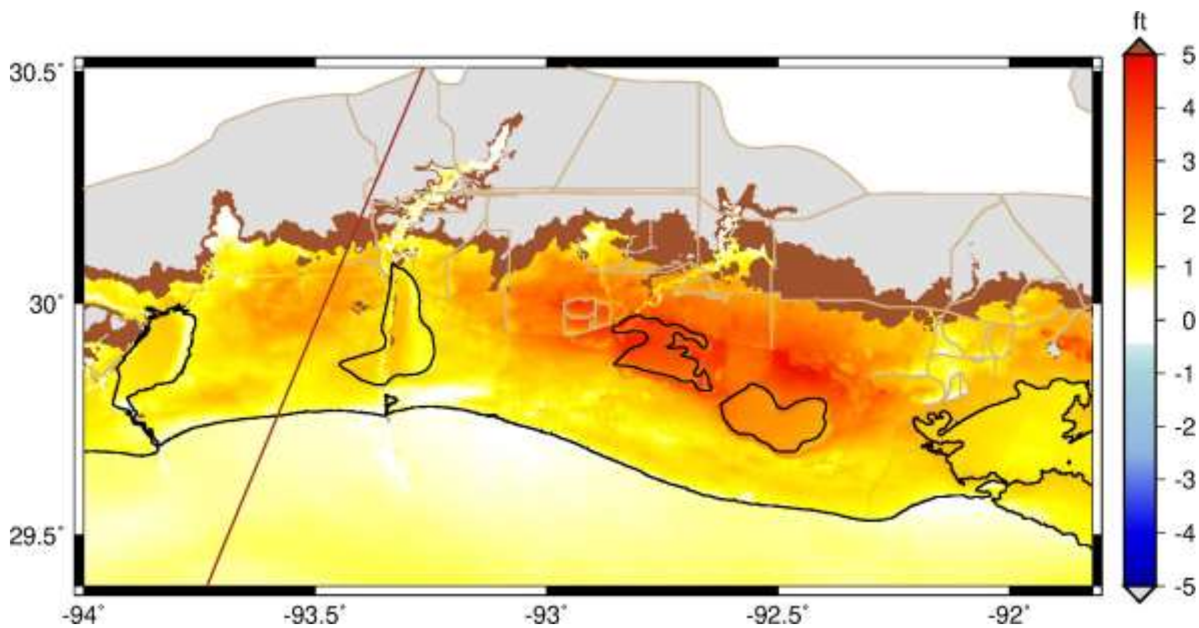

Figure 234. Change in peak wave height between Year 50 and Year 0 in the higher scenario.

6.4 FLOOD DEPTH PROJECTIONS

LOWER SCENARIO

Figure 235 shows the projected 10% AEP of flooding for the Chenier Plain region in a lower scenario from Year 20 to Year 50. Flood depths are less than 10 feet across the entire region in Year 20. Then the areas with over 10-foot flood depths extend from Grand Chenier to beyond from Year 30 onwards. In Year 50, Pecan Island and surrounding portions of Vermilion Parish have flood depths over 10 feet. Lake Charles has relatively lower flood depths (1-7 feet) over this 50-year period.

Changes in the 10% annual chance flood depths in the lower scenario are shown in Figure 236. The extent and magnitude of flooding in this region is relatively modest. Over time, the largest change in flood depths occurs in Grand Chenier and the eastern shores of Calcasieu Lake and White Lake, with an increase of 3-4 feet over 50 years. These areas are mostly unpopulated except for Cameron, which is to the south of Calcasieu Lake.

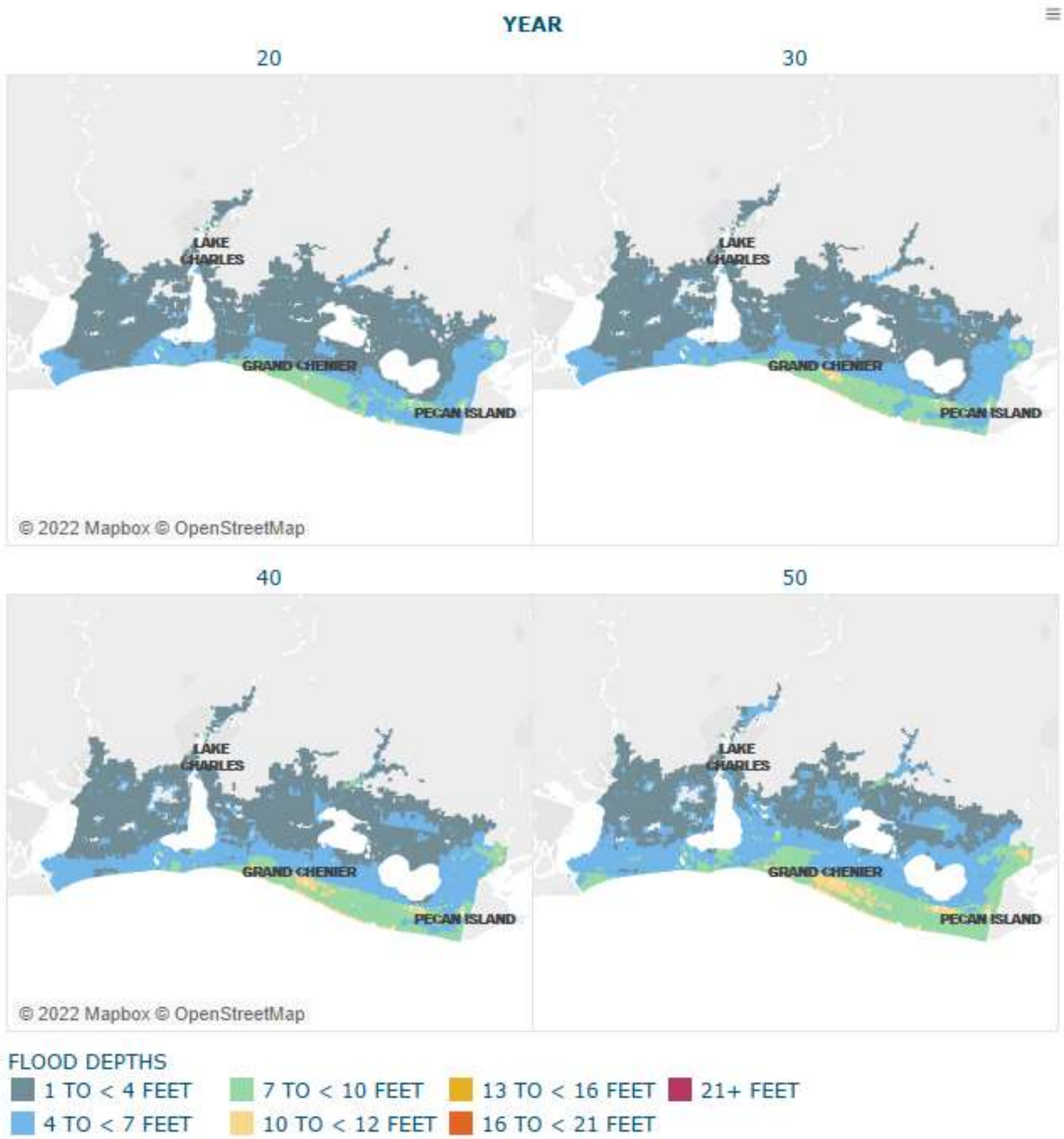

Figure 235. 10% annual chance (1 in 10-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

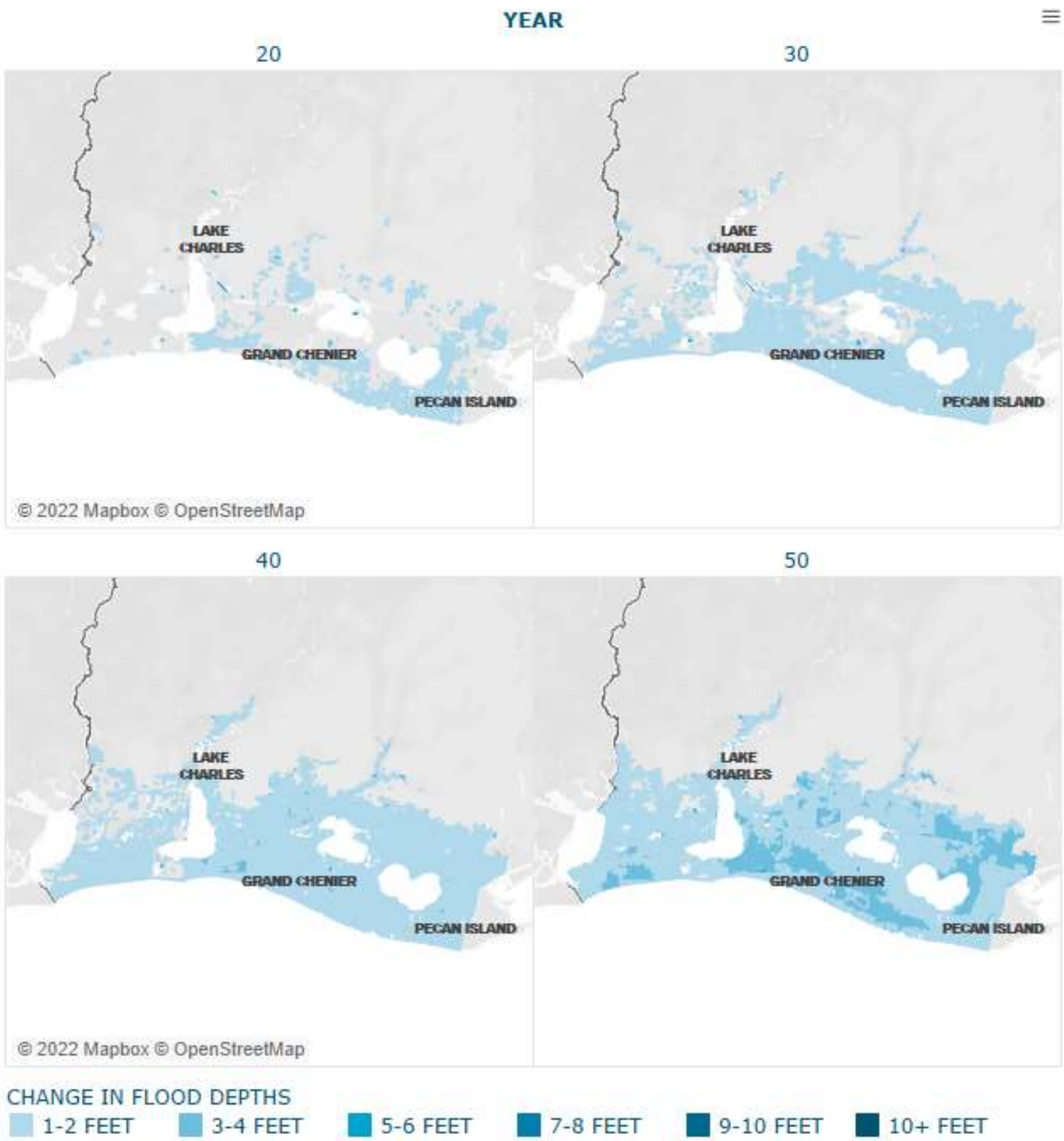

Figure 236. Change in 10% annual chance (1 in 10-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The 1% annual chance flood depths demonstrate that the whole region south of the cheniers along the Gulf, including Grand Chenier and Cameron, have over 10-foot depths starting from Year 20. Flood depths are generally greater for the areas closer to the shore (Figure 237). Over this 50-year period, the floodplain extends further inland, encroaching to the east of Sabine Lake and the north of Calcasieu Lake. In Year 50, most areas closest to the shore contain flood depths of over 13 feet, with the southwest corner of this region and sporadic areas around Grand Chenier having over 16-feet of flooding.

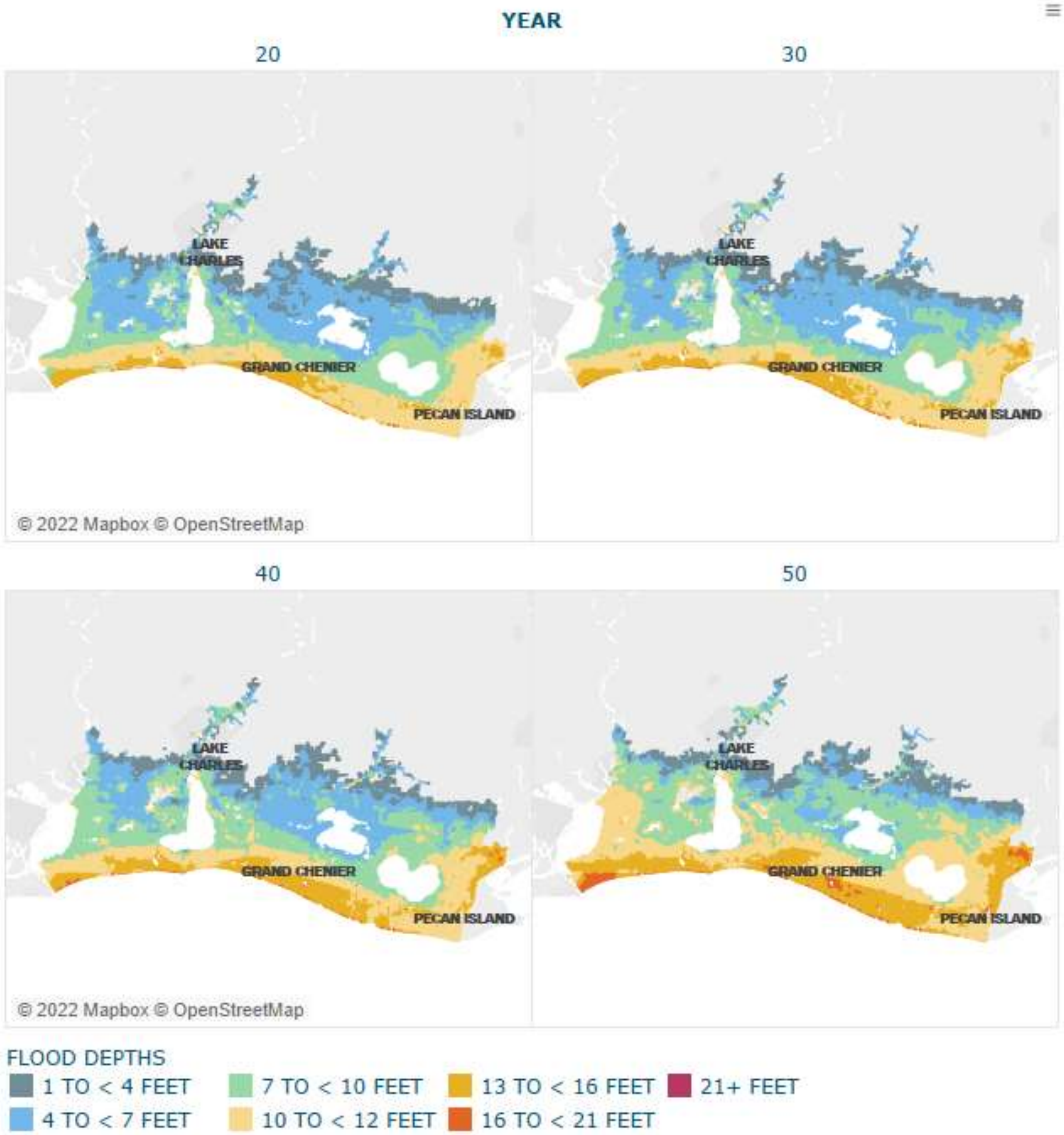

Figure 237. 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The 1% annual chance flood depths generally show a linear pattern but accelerates in the last decade (Figure 237). By Year 40, the change in flood depths is less than 2 feet across nearly the whole

Chenier Plain region. In Year 50, the area with depth changes of more than 3 feet expands to most of the areas, except the ones around Calcasieu Lake and east of White Lake. Cameron, which sees a change of over 3 feet in depth at the 10% AEP, shows an increase of 1-2 feet in this case.

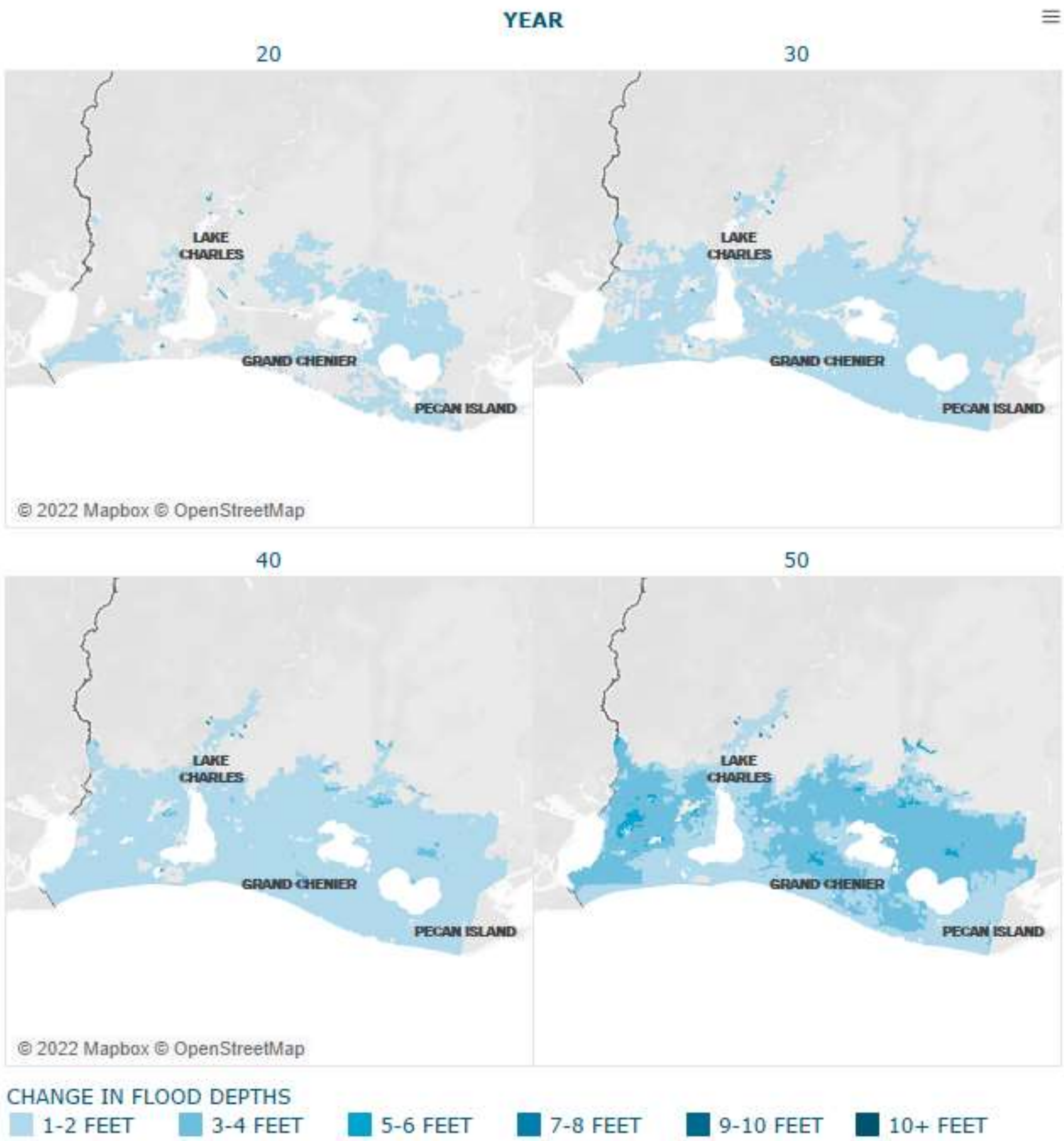

Figure 238. Change in 1% annual chance (1 in 100-year) flood depths in a Lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

HIGHER SCENARIO

Figure 239 demonstrates flood depths with a 10% AEP in a higher scenario over time. The spatial distribution of flood depths is similar to that in the lower scenario. Greater depths still exist around Grand Chenier south of LA 82, but also to a wider range of areas in this scenario. In Year 50, the largest flood depths exist at the southeast margin of the Chenier Plain region, while in the lower scenario, the inundation of over 10 feet does not reach the east border to Vermilion. Most of the Lake Charles areas faces 4-7 feet of flooding instead of 1-4 feet as in the lower scenario.

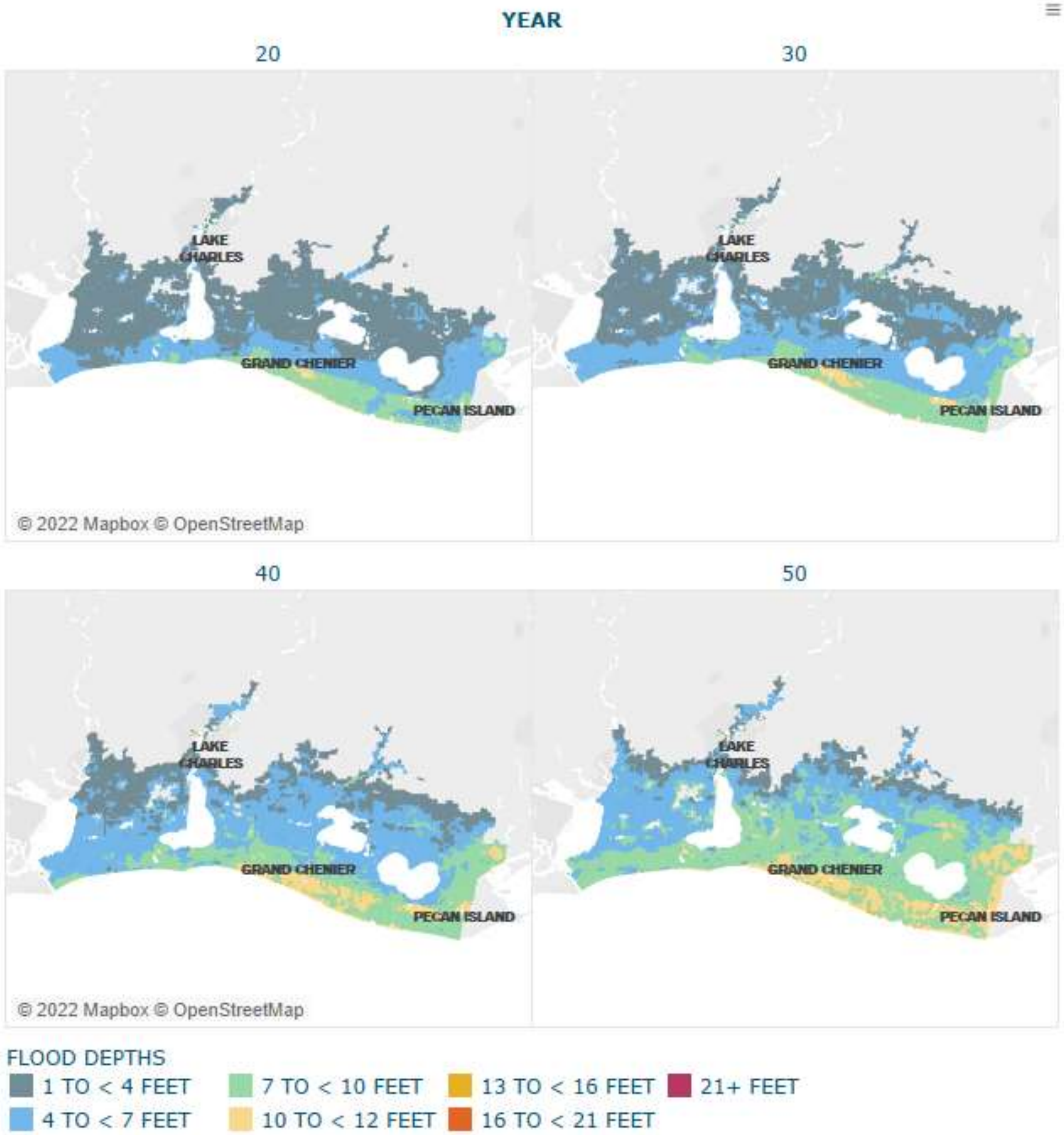

Figure 239. 10% annual chance (1 in 10-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Unlike the lower scenario, the largest change of 1 in 10-year flooding occurs to the north of White Lake, with an increase of over 9 feet (Figure 240). The increased flood depths along the east shore of Calcasieu Lake and Grand Chenier is similar between the two environmental scenarios in the first 30 years. However, the flooding increases 1-2 feet per decade in the last two decades. As noted previously, the most densely populated area, Lake Charles, experiences a notable increase in flooding, especially in the last two decades.

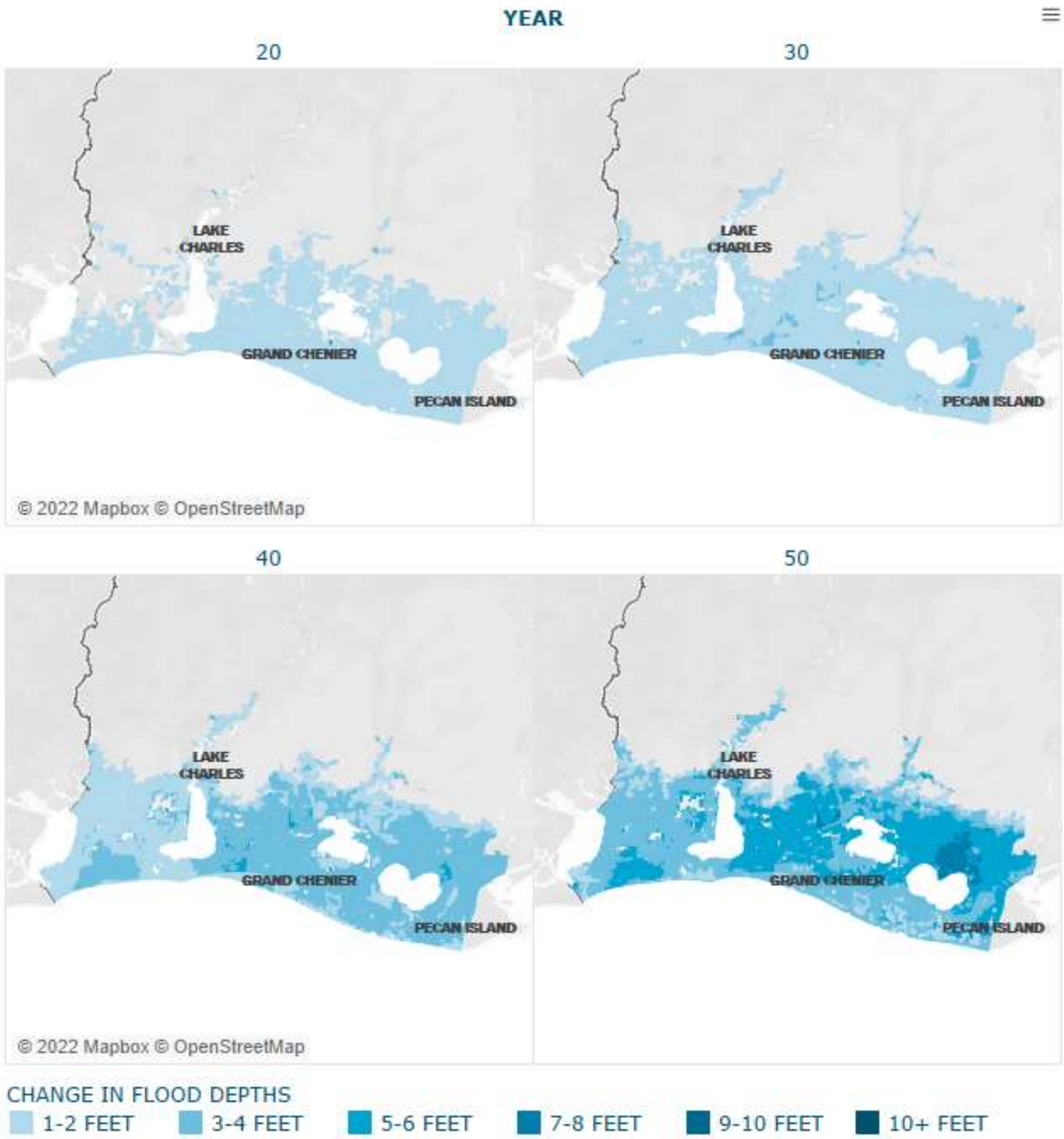

Figure 240. Change in 10% annual chance (1 in 10-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

1% annual chance flood depths in a higher scenario are over 10 feet since Year 20 in the region south of the cheniers along LA 82, which is seen in the lower scenario (Figure 241). The main difference in future years is that the floodplain expands further inland. In Year 50, it almost reaches Lake Charles and other populated communities around Interstate 10. In terms of magnitude, the wetlands and open water areas around Grand Chenier experience over 16 feet of flood depths. The north and east shore of White Lake are also impacted by a greater amount of flooding. Overall, most areas around the lakes in this region have over 10-feet of flood inundation by Year 50 at the 1% AEP.

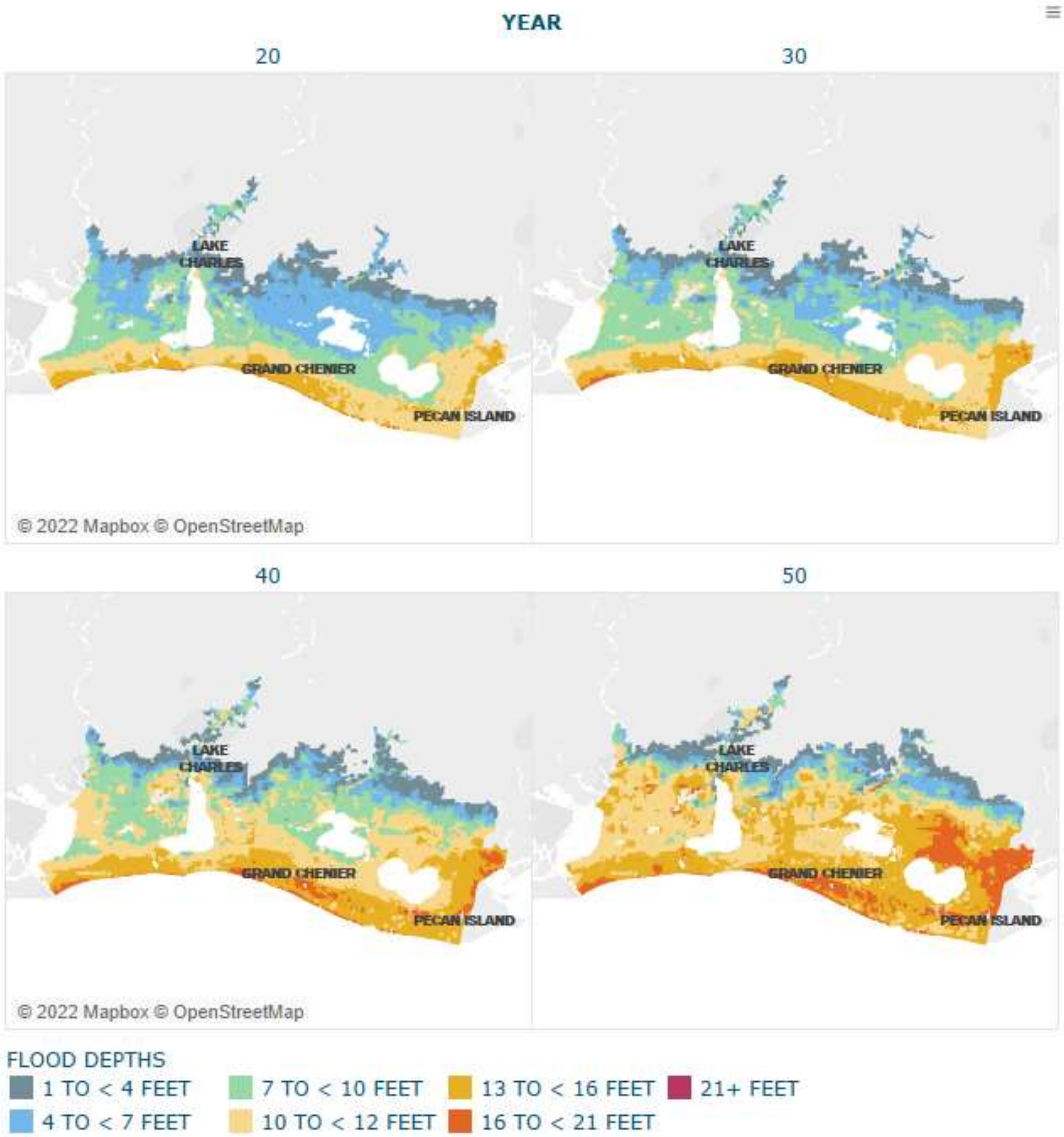

Figure 241. 1% annual chance (1 in 100-year) flood depths in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

In Year 20, the change within 1% AEP flood depths is lower than 2 feet everywhere in the Chenier Plain region (Figure 242). Increased flooding becomes progressively concentrated in areas around the lakes such as White Lake and Grand Lake, with an increase in over 9 feet in many areas. Populated communities along Interstate 10 have a consistent increase of 0.5-1 feet flood depths per decade.

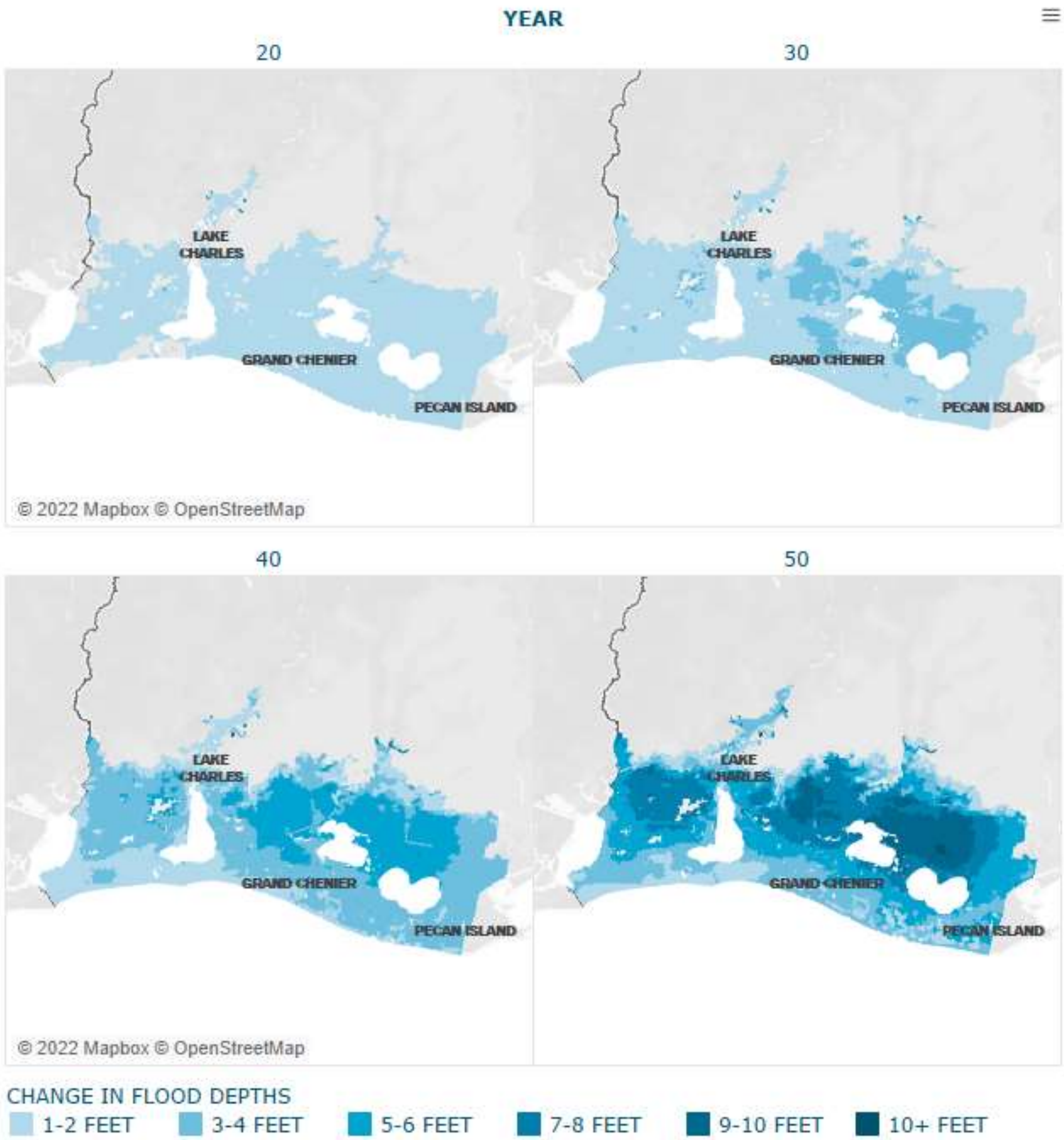

Figure 242. Change in 1% annual chance (1 in 100-year) flood depths in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

DISCUSSION

The simulations of flood depths for the Chenier Plain region show increases in both the extent and magnitude over the period of analysis. These increases are generally linear in the lower scenario over time, but the depth trends accelerate over time in the higher scenario, especially in the last two decades. This is primarily due to the different SLR assumptions for the two environmental scenarios, resulting in deeper and more widespread flooding in the higher scenario.

For both scenarios, higher flood depths occur in areas closer to the coast. The northern part of this region starts with a small amount of inundation. Over time, the floodplain steadily extends further inland, encroaching to populated communities and roads such as Hackberry and Lake Charles. In the higher scenario, this expansion is faster and ranges wider across this region. The Chenier Plain region contains several estuarine lakes. The flooding is concentrated in the areas along those lakes, especially White Lake.

6.5 FLOOD DAMAGE PROJECTIONS

LOWER SCENARIO

The majority of communities with severe exposure to inundation by a 2% AEP flood event are around the large lakes and also closer to the coast (Figure 243). As exceptions, populated communities around Calcasieu Lake, including Cameron, Lake Charles, and Hackberry, are vulnerable but face moderate exposure to flooding. Overall, the magnitude of the proportion of single-family residences with exposure to flooding at this AEP stays relatively stable over time.

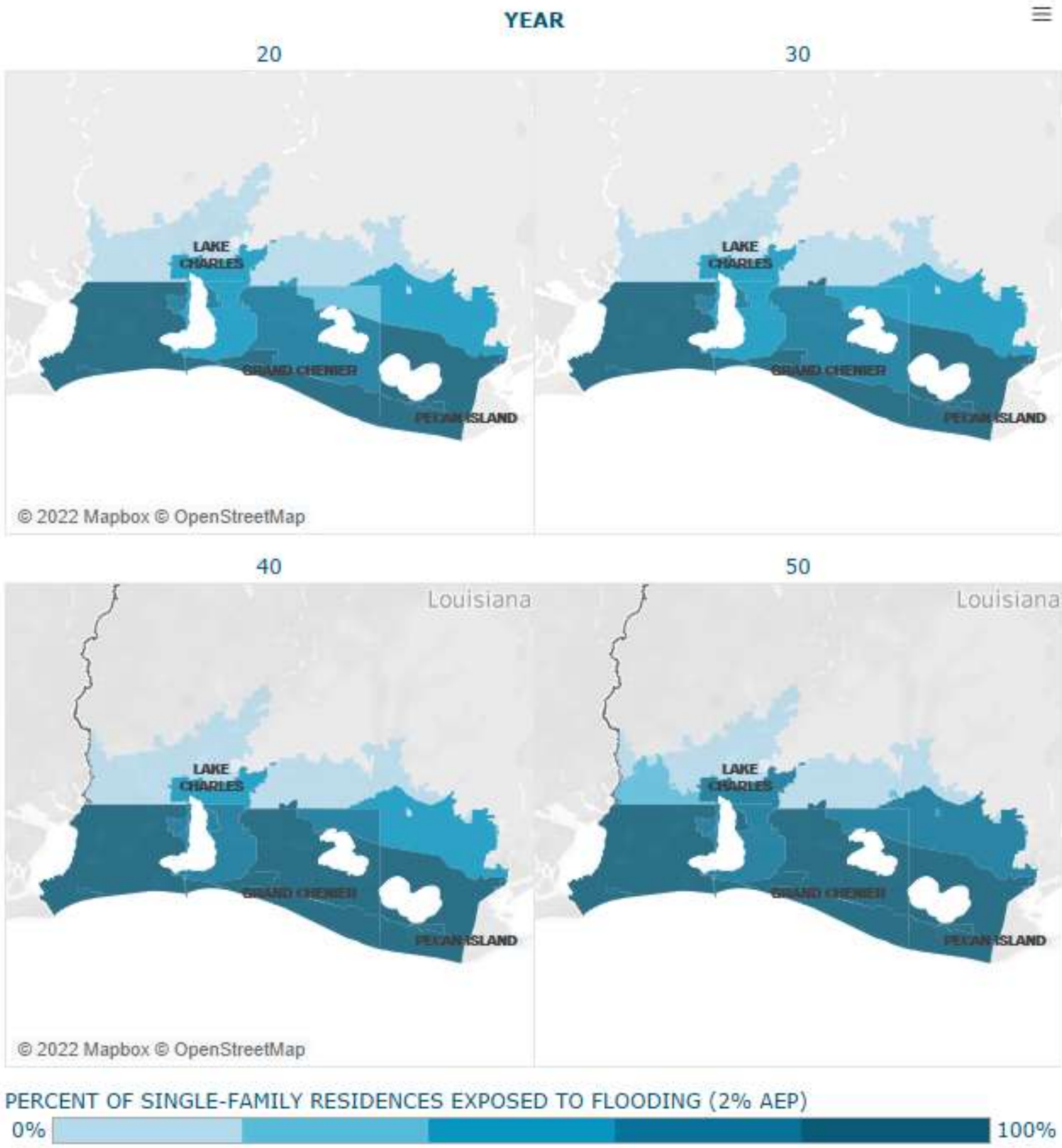

Figure 243. Residential structures exposed to 2% annual chance (1 in 50-year) flood depths above first floor elevation in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Figure 244 summarizes the counts of single-family residences exposed to flooding across the entire region over the period of analysis. In Year 0, 56% of single-family residential structures were not exposed to 2% annual chance (1 in 50-year) flooding, with 18% of structures experiencing over moderate exposure. The former rate declines to 52%, while the latter one increases to 23% by Year

50. It is notable that the counts of structures that experienced moderate exposure remained mostly unchanged over time, while the ones that experienced severe exposure increased by 83%, rising from approximately 6,000 to 11,000 over this 50-year period.

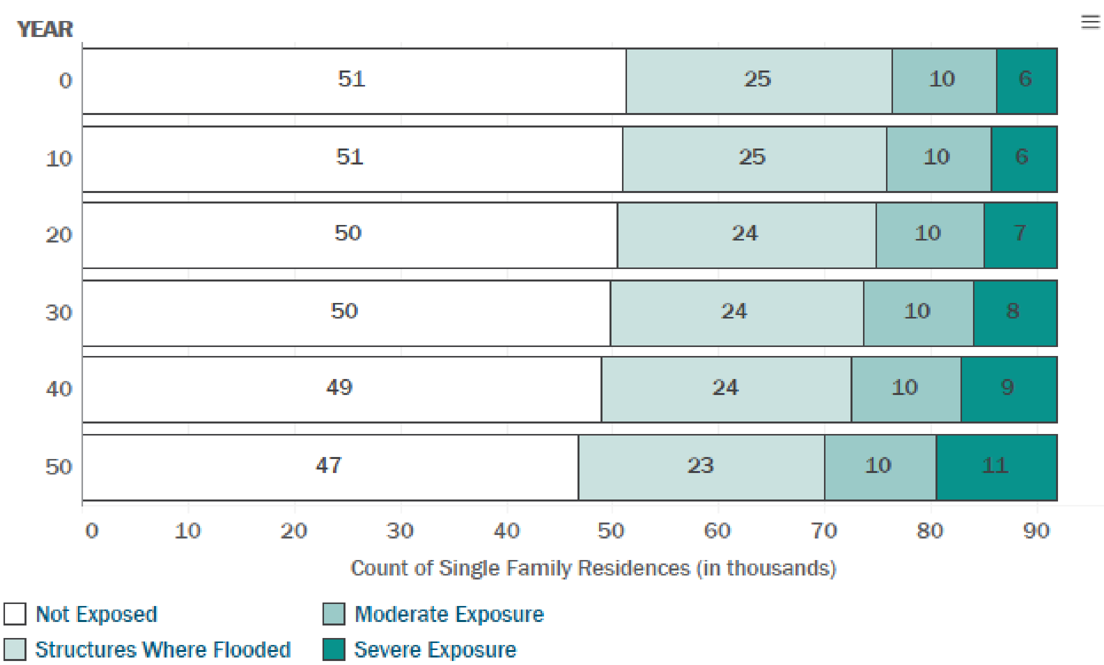

Figure 244. Residential structures exposed to 2% annual chance (1 in 50-year) flooding by exposure category in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile. Note: existing residences only, not accounting for population change.

There are two notable points when summarizing the potential economic risk across the entire Chenier Plain region (Figure 245). First, this region experiences $0.4 billion losses and costs under the initial conditions in Year 0, and this value stays unchanged for three decades. Since Year 30, the increase is about $0.1 billion per decade, nearly doubling to $0.7 billion in Year 50. Among these losses and costs, structural damage only makes up a small portion — less than 25% — of the total damage. Second, the EASD of single-family residences does not always increase over time. There is a decline in Year 10 and then a slow increase over the next 30 years, followed by a rapid increase in the last decade. Overall, EASD increases from 316 to 520 in the lower scenario over the period of analysis.

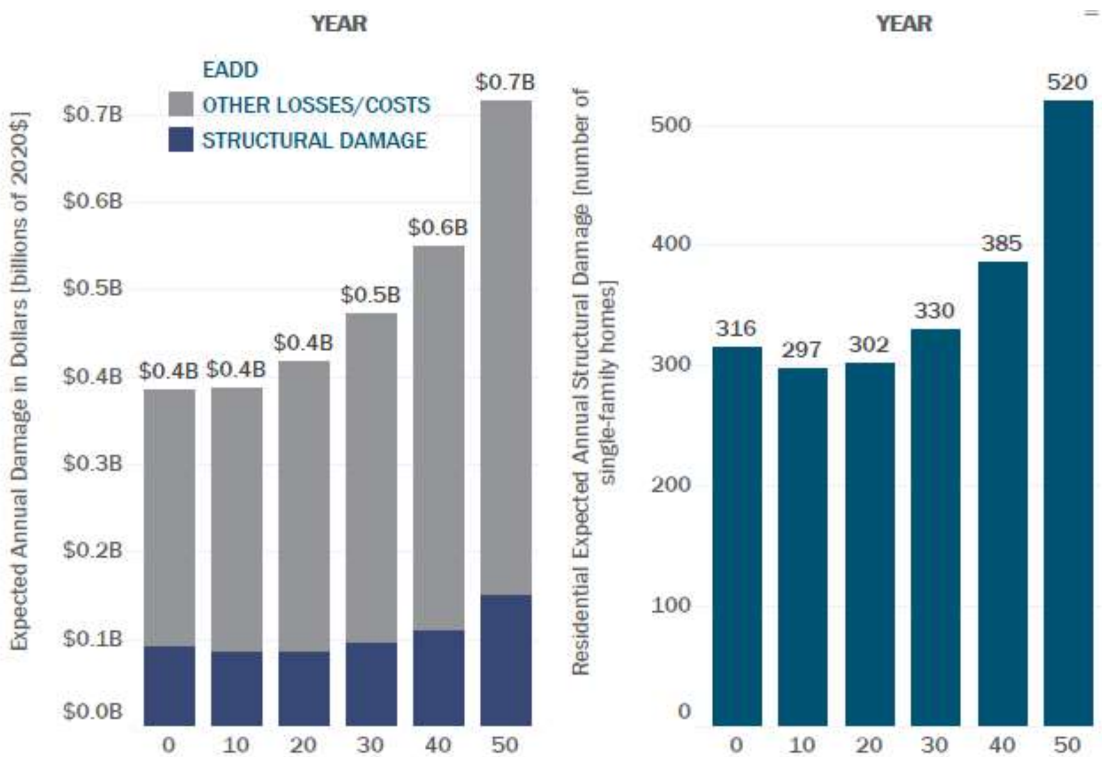

Figure 245. EADD (left) and residential EASD (right) in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

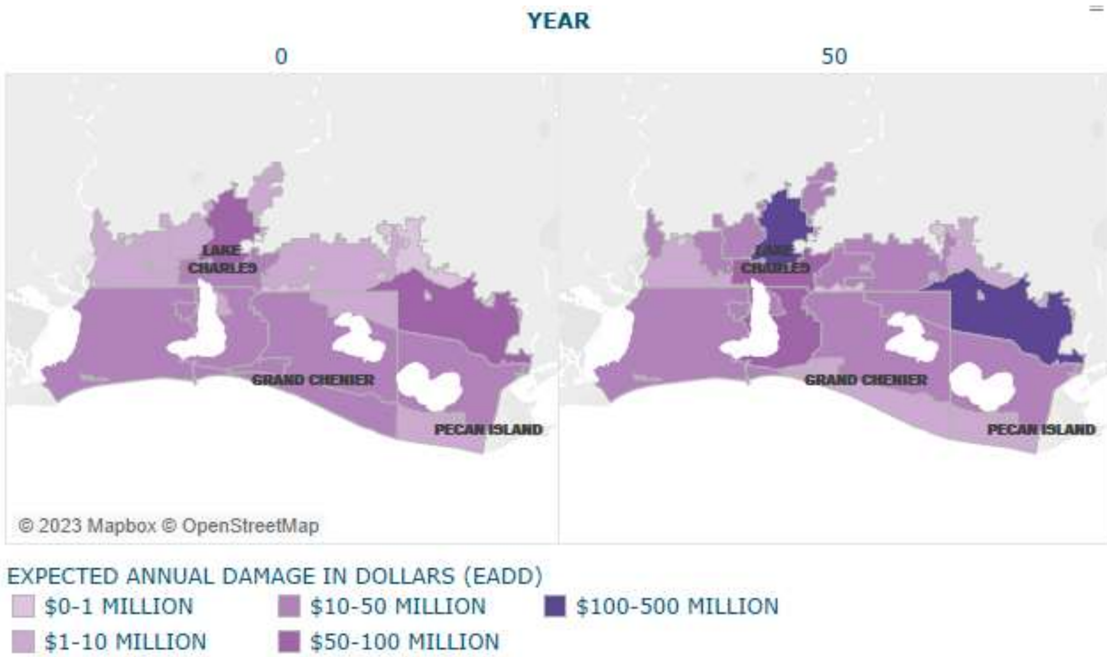

Figure 246. EADD by community in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

In Year 0, EADD by community in the lower scenario is less than $10 million everywhere over the Chenier Plain region. By 2070, the floodplain expands further inland, with the largest concentrations of EADD occurring in Lake Charles and northern Vermilion Parish. Generally, the communities around the lakes experience greater economic risks than others (Figure 246).

Lake Charles and northern Vermilion Parish not only comprise the largest concentrations of EADD, but also experience the largest change in economic risk over time, with an increase of over $10 million by Year 50 (Figure 247). Notably, the communities closest to the coast, including Cameron and southern Vermilion Parish, see a decline in EADD over time.

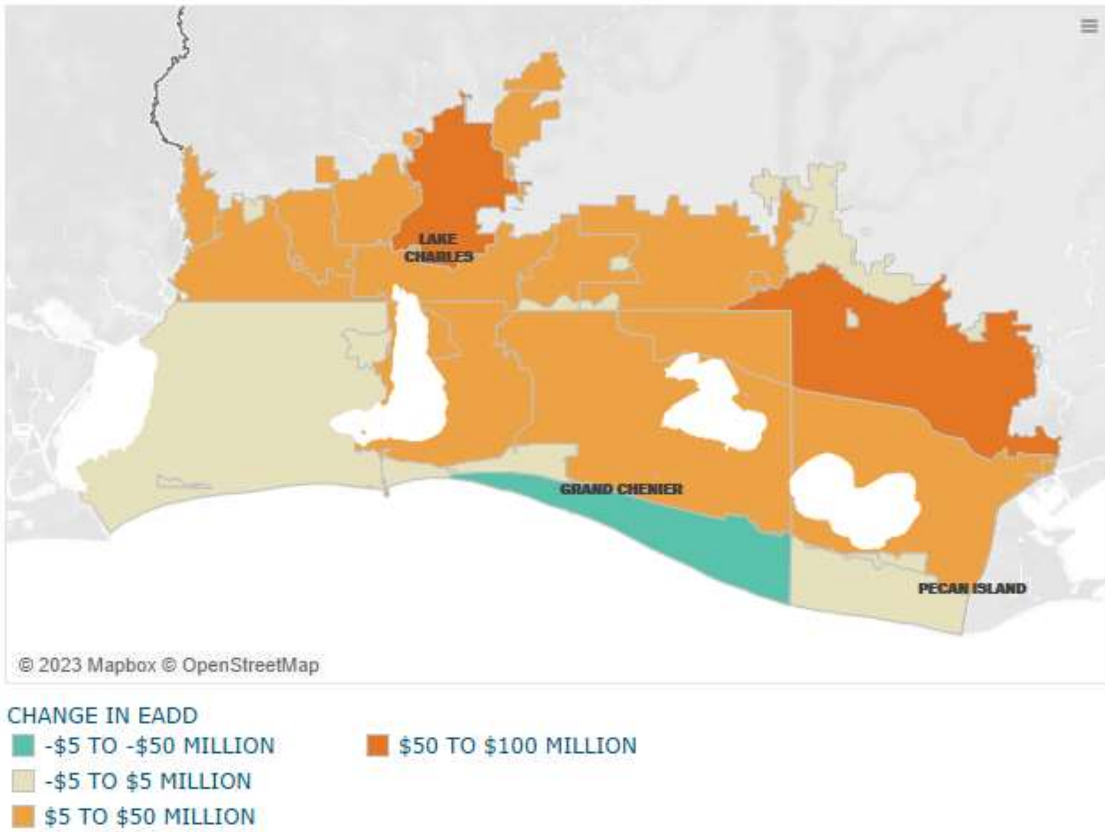

Figure 247. Change in expected annual damage by community in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile, Year 50 – Year 0.

Lake Charles/Prien had the largest concentration of both the trend over time and level of EADD over the 50 years in the lower scenario (Figure 248). It is notable that Lake Charles/Prien, which are populated communities, has a substantial increase in EADD over time (from $50 million in year 10 to $150 million in Year 50), almost tripling across the simulation period. The level of EADD declines in first 20 years and then shows a modest increase in following years. Grand Lake sees a linearly modest increase over time while Grand Chenier sees a slight decline in EADD over time.

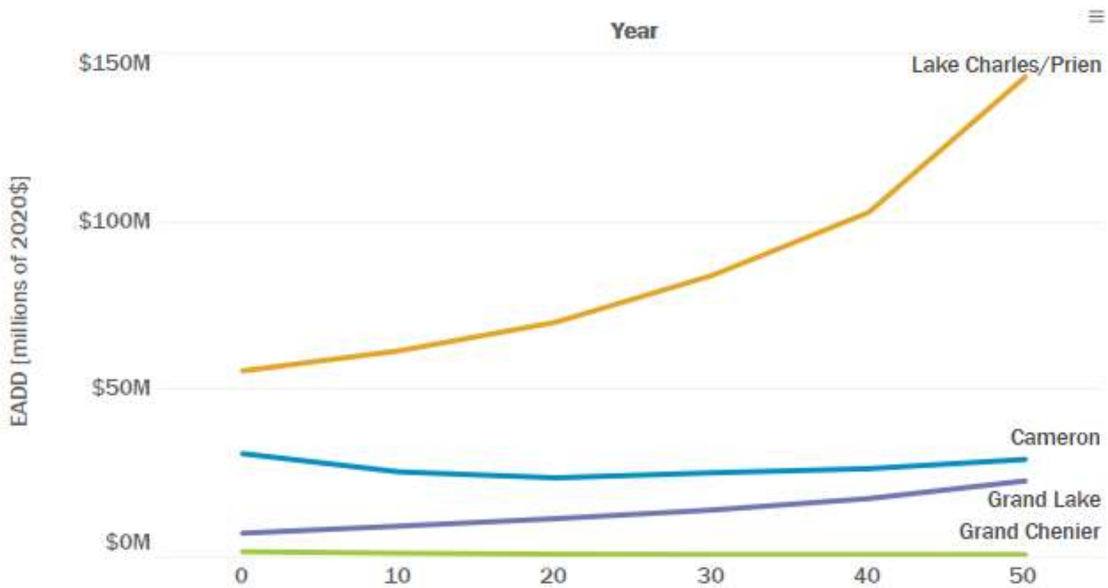

Figure 248. EADD in selected Chenier communities over the 50-year simulation period in a lower scenario — IPET fragility, 50% pumping scenario, 50th percentile.

HIGHER SCENARIO

Over the period of analysis in the higher scenario, the spatial pattern of projected exposure to flooding is similar to that in the lower scenario (Figure 249). The set of communities that are closer to the lakes and the shore of Gulf still experience more exposure than others. However, it is notable that the percentage of assets with moderate to high exposure to flooding by Year 50 at the 2% AEP is greater than in the lower scenario. Populated communities around Calcasieu Lake such as Cameron and Lake Charles show higher exposure in earlier decades.

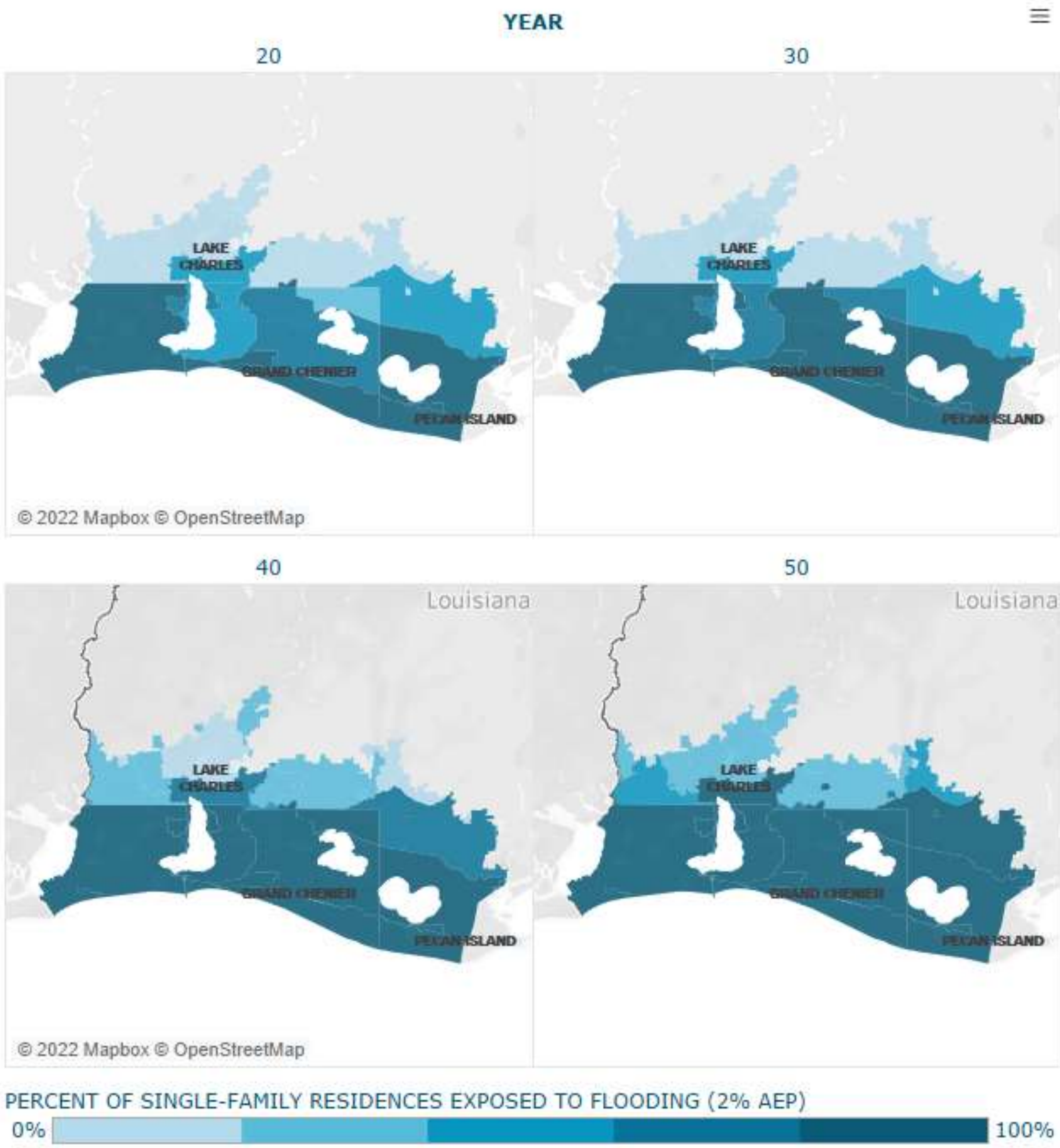

Figure 249. Residential structures exposed to 2% annual chance (1 in 50-year) flood depths above first floor elevation in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

The residential structure exposure in a higher scenario for the Chenier Plain region is summarized in Figure 250 from the 2% annual chance (1 in 50-year) flood depth. This figure highlights that the increase in number of structures with exposure to flooding accelerates in the last two decades. This might be due to the SLR rate assumption in this scenario. There are 52% of structures not being exposed to flooding in the lower scenario, while in the higher scenario, this percentage is reduced to 43% in Year 50. Another notable change is the number of structural assets facing severe exposure. This number increases from approximately 11,000 to 20,000, with a rise of 10% over 50 years.

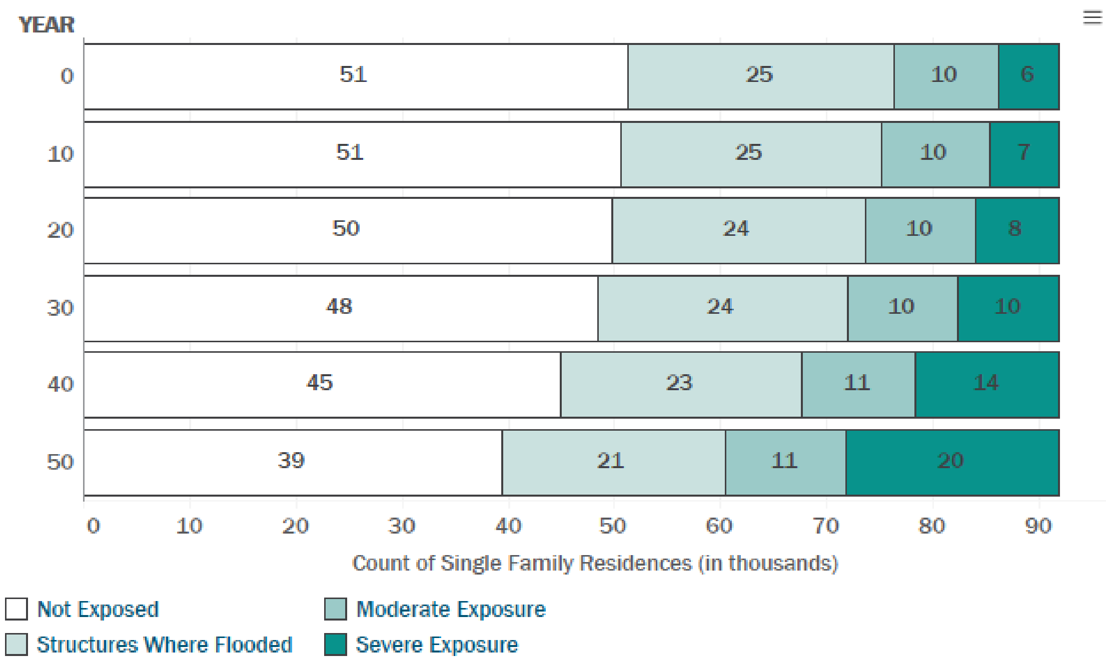

Figure 250. Residential structures exposed to 2% annual chance (1 in 50-year) flooding by exposure category in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

EADD in the higher scenario shows a similar increasing pattern to the lower scenario (Figure 251). There is a more linear increasing trend in the earlier decades, followed by a rapid increase in the last two decades. By Year 50, EADD jumps to $1.5 billion, almost quadrupling that in Year 0. As noted previously, the percentage of structural damage always takes a very small portion of the total EADD across the whole simulation. The increase of EASD has a similar accelerating rate in EADD over time. In the last two decades, EASD increases much faster, with a change in 265% over initial counts in Year 0.

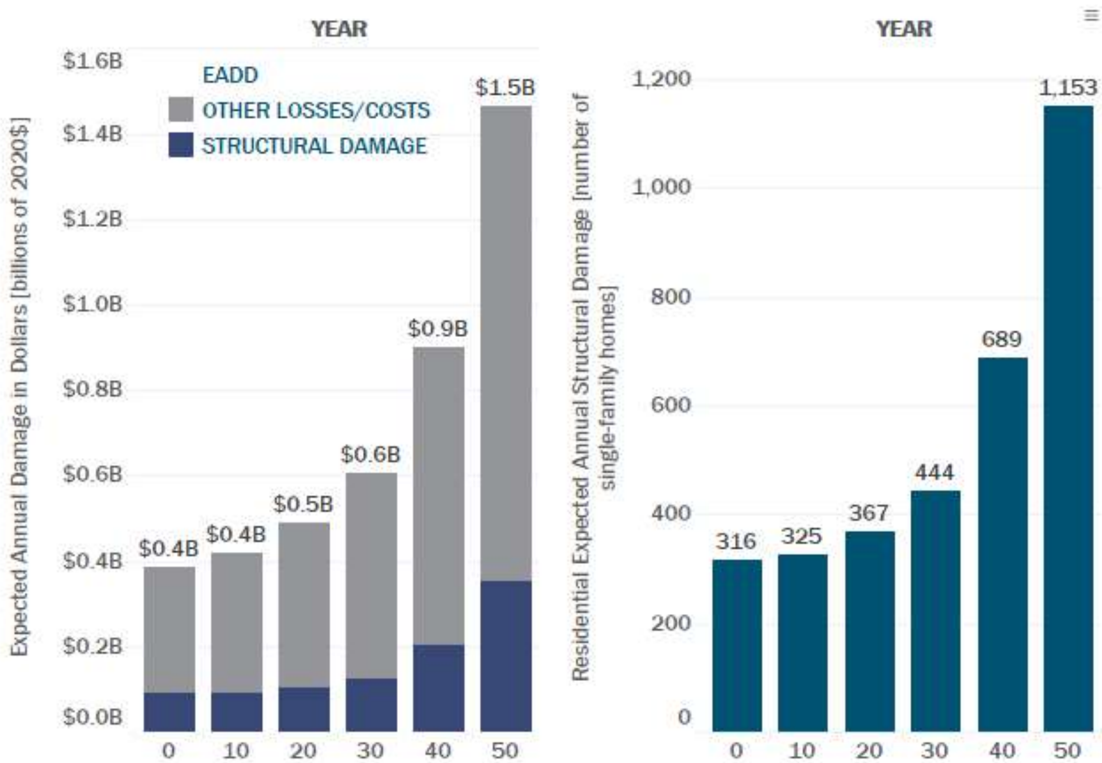

Figure 251. EADD (left) and residential EASD (right) in the Chenier Plain region in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

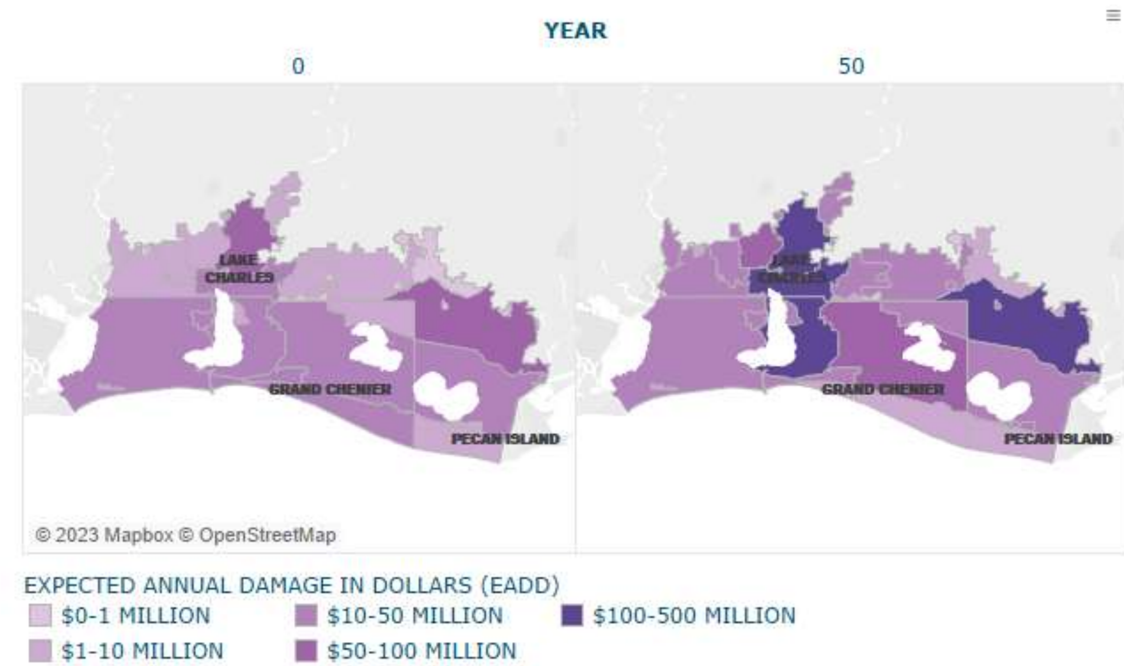

Figure 252. EADD by community in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

Compared to the lower scenario, a larger set of communities sees higher EADD in Year 50 (Figure 252). The largest concentrations of EADD occur in Lake Charles and northern Vermilion Parish, as in the lower scenario. Cameron and Hackberry, which are populated communities, experience over $100 million in Year 50. This does not occur in the lower scenario. Overall, there is no substantial change in either magnitude or extent of economic risk between the two scenarios.

In terms of the change in EADD in a higher scenario, fewer communities see a decline in EADD over time (Figure 253). Western Cameron and northern Vermilion Parishes, which have negative $1 to $10 million changes in EADD, now experience $1 to $10 million increases over the period of analysis. Nearly the entire community of Cameron faces an increase in EADD change, except for the portion on the eastern shore of Calcasieu Lake. The communities with the largest change in EADD are Lake Charles and the northern portion of Vermilion Parish.

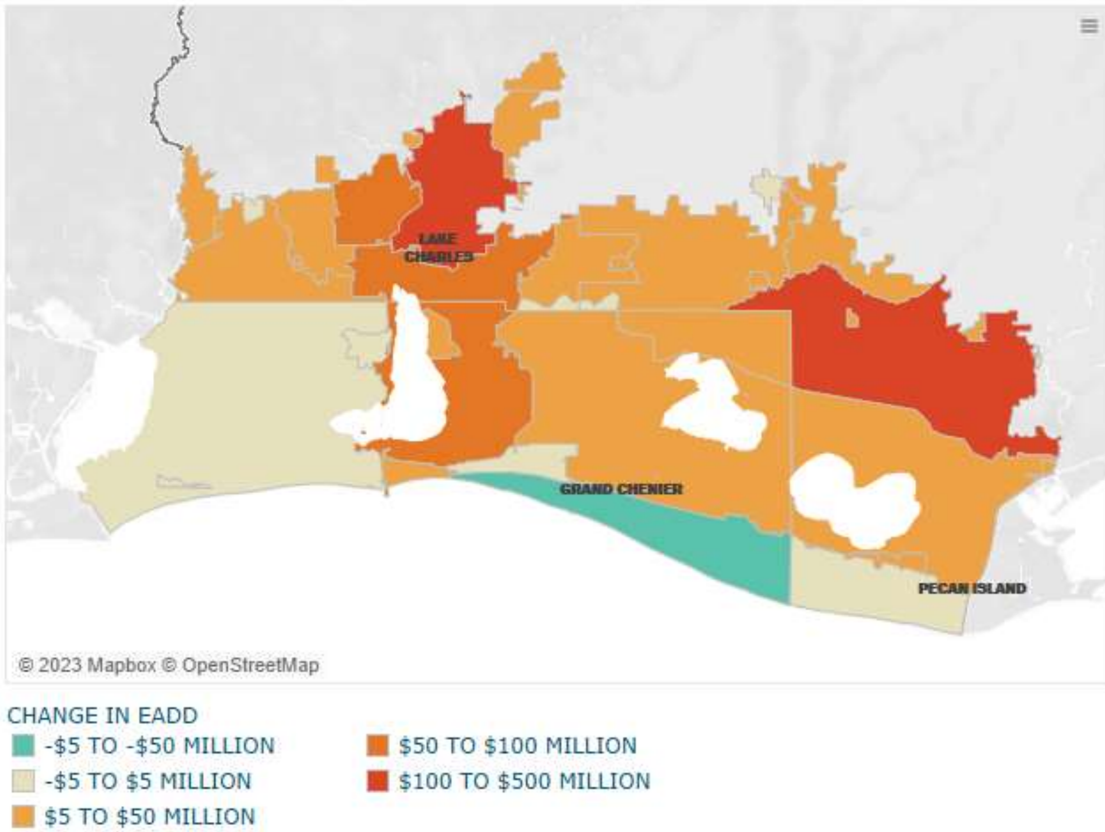

Figure 253. Change in expected annual damage by community in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile, Year 50 – Year 0.

Compared to the lower scenario, EADD estimates are substantially higher with a faster increasing rate in the higher scenario, while Grand Chenier still sees largely unchanged EADD over time (Figure 253). In both Year 30 and Year 40, there is an acceleration in the increase for Lake Charles/Prien and Cameron. The increase is especially notable for Lake Charles/Prien; EADD jumps from $50 million in Year 0 to almost $400 million in Year 50.

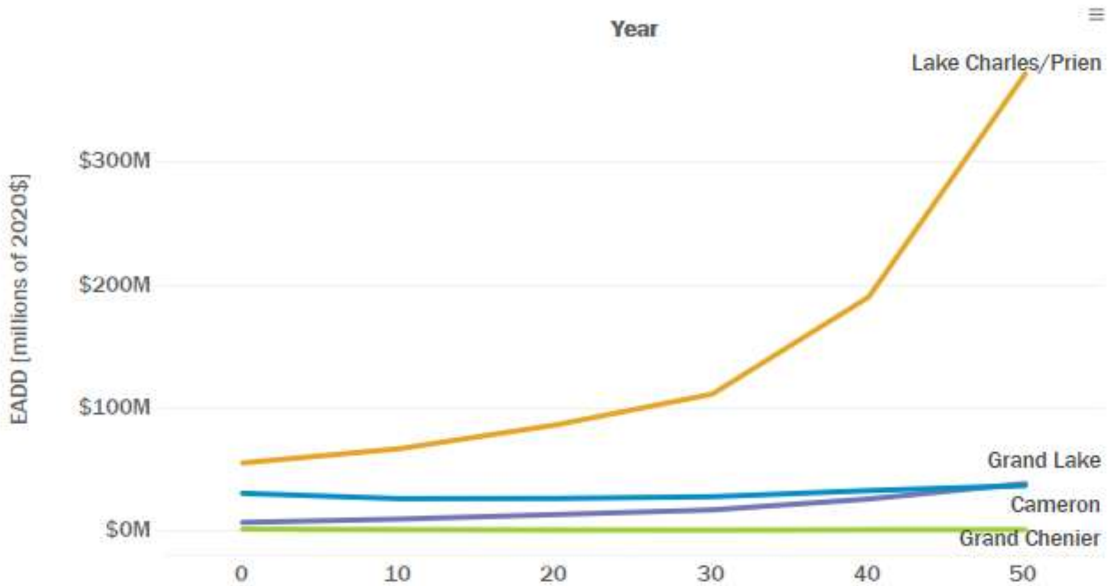

Figure 254. EADD in selected Chenier Plain communities in a higher scenario — IPET fragility, 50% pumping scenario, 50th percentile.

DISCUSSION

The simulations in the Chenier Plain region show that economic damage increases more linearly in the early decades, but with a much higher acceleration rate in the last two decades. In the higher scenario, EADD increases quicker than in the lower scenario. The areas with exposure to flooding and economic damage generally follow the spatial pattern of the flood depth simulations. The communities that are near the lakes and the Gulf face greater risk over time. This holds true for both scenarios. An exception is Lake Charles, which has less flooding but contains the largest concentrations of economic risk. This is likely because it is more populated than many other communities.

In the higher scenario, the level of exposure increases in earlier decades and the percentage of structural assets with moderate to high exposure is greater, especially because more structural assets are at risk to severe exposure in Year 50. The assumptions related to SLR acceleration rates in these two environmental scenarios are likely the primary driver. In the lower scenario, a larger portion of the southern part of the Chenier Plain region experiences a decline in EADD over the period of analysis, but this portion shrinks only to the southern margin of Cameron Parish in the higher scenario.

7.0 CONCLUSION

This report presented the simulation modeling results projecting coastal flood risk and damage over a 50-year period in a FWOA. Results described in this analysis were simulated with the ADCIRC, SWAN, and CLARA models to inform the development of Louisiana's 2023 Coastal Master Plan. The document described projected FWOA storm surge and wave heights, flood depths, exposure of single-family residences, and flood damage for coastal Louisiana. Key storylines were presented for each of the five regions across the Louisiana coastline and for two environmental scenarios defined for the 2023 analysis. This approach is consistent with the presentation of biophysical outcomes from the ICM, which served as a key input for this analysis.

Looking coastwide, the FWOA flood risk analysis results show dramatic increases in flood depths, community and asset exposure to flooding, and flood damage over the 50-year projection if no additional action is taken. These increases are noted in both scenarios and across all regions of the coast, but the higher scenario in particular shows accelerating exposure and damage in later decades (year 40-50) driven primarily by an accelerating rate of SLR. Present and future flood risk results described in this report undergird the need to take action in the master plan in order to reduce risk to people and assets across Louisiana's coastal communities.

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